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STUDIES OF NO_x REACTIONS AND O_3 TRANSPORT IN SOUTHERN CALIFORNIA - FALL, 1976

by

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The report describes a four week study of oxides of nitrogen chemistry and ozone transport in and around the southcoast air basin of California in the fall of 1976. The data base was obtained using three ground-level monitoring stations and a twin engine instrumented aircraft. Measurements made at ground sites included ozone, nitric oxide, oxides of nitrogen, nitric acid, peroxyacetylnitrate, sulfur dioxide, Freon-11, nonmethane hydrocarbon, carbon monoxide, methane, ethane, nitrate, sulfate, ammonium, and total nitrogen. The aircraft made up to three flights per day measuring ozone, nitric oxide, oxides of nitrogen, peroxyacetylnitrate, nonmethane hydrocarbon, methane, carbon monoxide, ethylene, ethane, Freon-11 and temperature. The report discusses the ground-station data in terms of aerosol nitrogen balance, size distribution of aerosol constituents, distribution of oxidized nitrogen, nitrogen/sulfur relationships and nitrogen mass balance. Aircraft data are used to support the ground station data and the conclusions made from data analysis.

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ABSTRACT

This report describes a four week study of NO_x chemistry and O_3 transport in and around the southcoast air basin of California. The data base was provided by three ground-level monitoring stations and a twin-engine instrumented aircraft. The ground stations were located approximately 20, 35, and 50 miles from central Los Angeles in the prevailing downwind direction. Measurements were made at each of these sites from 0900-1700 PST for O_3, NO, NO_x, HNO_3, PAN, SO_2, F-11, NMHC, CO, CH_4, C_2H_2, C_2H_4, NO_3^-, $SO_4^=$, NH_4^+ and total N. The aircraft made up to three flights per study day measuring O_3, NO, NO_x, PAN, NMHC, CH_4, CO, C_2H_2, C_2H_4, F-11 and temperature. In all, 42 monitoring flights were conducted over the 22 study days.

The results of the study are summarized in tables and listed in detail in appendices. A subset of 11 photochemically active days has been selected and average pollutant profiles and air quality trends for these days are examined. The ground station data are discussed in terms of aerosol nitrogen balance, size distribution of aerosol constituents, distribution of oxidized nitrogen, nitrogen/sulfur relationships and nitrogen mass balance. Four specific study days were selected for detailed analysis as case studies. The aircraft and ground data for these days are examined for evidence of ozone transport, oxidized nitrogen distribution, nitrogen balance, and NO_x transformation rate.

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SECTION 1

INTRODUCTION AND BACKGROUND

This report presents the results of a field investigation of atmospheric transformations of nitrogen oxides (NO_x) and transport of ozone (O_3) conducted by Battelle Columbus Laboratories under the sponsorship of the Environmental Protection Agency (EPA). The program focuses on the reactions of nitrogen oxides and transport of O_3 in the urban plume of Los Angeles.

The ambient air reactions of nitrogen oxides are not well characterized, and previous efforts have focused on developing analytical methods suitable for studying such reactions, identifying the major NO_x reaction products, and quantifying the nitrogen mass balance. Earlier studies in Los Angeles confirmed smog chamber observations that peroxyacetyl nitrate (PAN) and nitric acid ($HONO_2$) are the major initial products of photochemical reactions of NO_x in polluted air. Over a 5 week period in Los Angeles, PAN accounted for 68 percent of reacted NO_x, $HONO_2$ accounted for 17 percent and particulate nitrate for about 3 percent. Approximately 12 percent of the reacted NO_x could not be accounted for as one of these products. The nitrogen distribution ratio, F_N*, averaged about 7 percent at night and 21 percent during the day at a site downwind of L.A. The earlier study provided the first measurements of ambient nitric acid and the first indication that nitric acid could be present at much higher concentrations than particulate nitrate. Little information on the rate of NO_x transformation to products was obtained, although an average pseudo-first order rate constant of 0.10 ± 0.05 hr^{-1} was consistent with most of the experimental data. The present investigation of NO_x reactions was designed to extend and validate the earlier results and provide more information on NO_x conversion rates. The program has involved detailed ground level and aircraft monitoring studies and the analysis and interpretation of the resulting data. This study builds upon earlier investigations of ozone transport in the Ohio Valley and New England, and on previous studies of NO_x chemistry in Los Angeles, St. Louis and Phoenix.

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* $F_N = \dfrac{PAN + HONO_2}{NO + NO_2 + PAN + HONO_2}$

OBJECTIVES

The overall objectives of the program are (1) to determine the distribution of atmospheric nitrogen compounds and relationships among these compounds and other atmospheric parameters and (2) to determine the propensity of air masses to generate and transport ozone over long distances. Specific objectives of the project are itemized below:

- to determine the spatial and temporal distribution of oxidized nitrogen species in the Los Angeles basin
- to determine the extent to which measured NO_x products can account for NO_x removal from the air (i.e., nitrogen mass balance)
- to investigate differences in the transformation processes for the nitrogen oxides relative to sulfur oxides
- to estimate the rate of NO_x transformation under photochemically reactive conditions
- to investigate the transport of ozone and precursors from urban areas.

PROJECT DESCRIPTION

The field measurements obtained as part of this study are a significant contribution to the currently available data on atmospheric nitrogen compounds and ozone behavior. The measurements are crucial to the success of the program since they provide the data which will be used to address the program's objectives. The field experiments were conducted in October-November, 1976, in southern California. Both ground level and airborne monitoring were conducted. Three separated ground stations and an instrumented twin engine aircraft were employed for monitoring. The data from the field experiments are contained in appendices to this report. Much of the data is also summarized within the report itself.

SECTION 2

SUMMARY AND CONCLUSIONS

This report presents the results of a field investigation of atmospheric transformations of nitrogen oxides and transport of ozone conducted by Battelle's Columbus Laboratories under the sponsorship of the Environmental Protection Agency (EPA). The program focuses on the reactions of nitrogen oxides in the urban plume of Los Angeles.

The field measurements obtained as part of this study are a significant contribution to the currently available data on atmospheric nitrogen compounds and ozone behavior. The measurements were crucial to the success of the program since they provided the data which have been used to address the program's objectives. The field experiments were conducted in October-November, 1976 in southern California. Both ground level and airborne monitoring were performed. Three separate ground stations and an instrumented twin engine aircraft were employed for monitoring.

This report describes the experimental aspects of the field program and an interpretation of the data as they relate to the program objectives. The study findings are summarized succinctly below.

- During the Los Angeles study, the highest concentrations of primary pollutants generally were observed at the Temple City site which is closest to the L.A. urban center. Highest concentrations of O_3 and PAN were measured downwind at the intermediate site in Upland, while the concentration of particulate nitrate was greatest at Rubidoux.
- Based on a subset of 11 photochemically active days, the average daytime distribution of oxidized nitrogen at the three ground stations was

	Temple City	Upland	Rubdioux
NO	21 ppb (19%)	5 ppb (10%)	$\leq$5 ppb -
NO_2	87 ppb (78%)	33 ppb (66%)	41 ppb (78%)
PAN	3 ppb (3%)	11 ppb (22%)	5 ppb (10%)
$HONO_2$	$\leq$6 ppb (-)	$\leq$6 ppb (-)	$\leq$6 ppb (-)
NO_3	0.8 ppb (1%)	0.6 ppb (1%)	6.1 ppb (12%)

The percentage of the total measured nitrogen contributed by each compound is shown in parenthesis.

- Particulate nitrate exhibited a strong east-west gradient in the Los Angeles basin, in contrast to sulfate, which was relatively uniform.
- The average accountability of total aerosol nitrogen as nitrate and ammonium ranged from 70-85% for the three ground stations. On the average, 47% of the NO_3^-, 90% of $SO_4^=$, and 100% of NH_4^+ was observed in particles $\leq$ 2.0 μm at Upland.
- When both gas and aerosol species are taken into account, the ratio of measured sulfur compounds to nitrogen compounds is quite close to the SO_x/NO_x emission inventory ratio.
- The data confirm our earlier finding that most of the urban nitrate is present in the gas phase. The fraction of urban nitrate which exists in gaseous form is shown below for several cities:

	Gaseous Nitrate / Total Nitrate
St. Louis (1973)	0.95
West Covina (1973)	0.98
Phoenix (1977)	0.50
Temple City (1976)	0.75
Upland (1976)	0.96
Rubidoux (1976)	0.45
Beverly, Mass. (1978)	$\geq$0.95

- Based on upwind tracer/NO_x ratios, the calculated nitrogen mass balances for Upland and Rubidoux show that ~ 90 percent of the nitrogen is accounted for.
- At both downwind sites (Upland and Rubidoux), NO_x conversion averaged 22 percent. Using average reaction times for air masses transported to these sites, a lower limit transformation rate of 0.02-0.03 hr^{-1} is calculated. On individual study days the NO_x removal rate reached 0.16 hr^{-1} and the rate of transformation to PAN ranged from < .01 to .08 hr^{-1}.

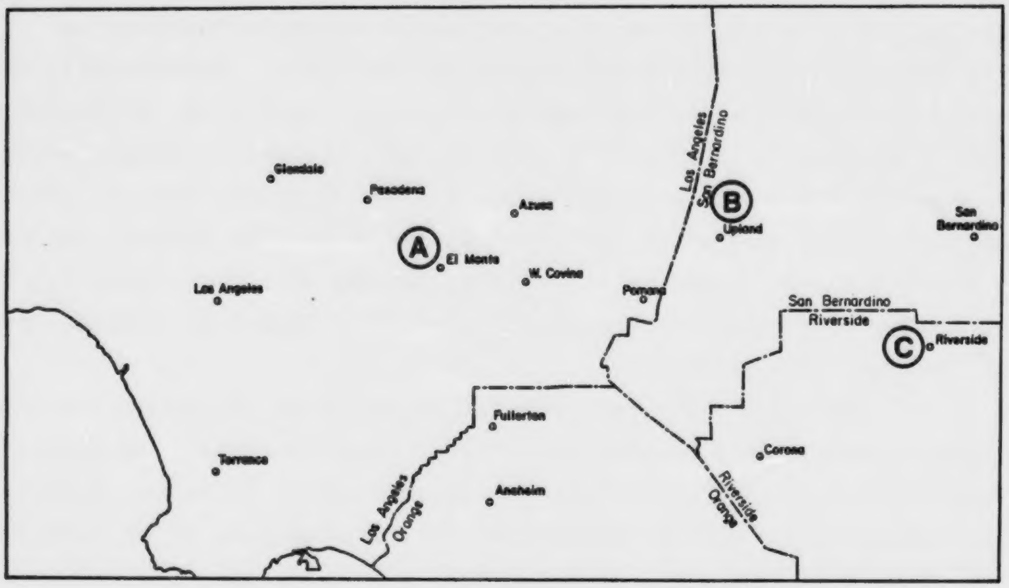
SECTION 3

SAMPLING SITES

Sampling was conducted at three ground stations in the Los Angeles basin. The location of the three stations is shown in Figure 1. A California Air Resources Board station in Temple City, approximately 20 miles east of downtown Los Angeles, served as site A. Site B was the Battelle mobile air quality laboratory located at Cable Airport in Upland, about 35 miles from Los Angeles. The mobile lab served as the base of operations, and was located only a few feet from the hanger for the research aircraft. A SCAPCD monitoring station in Rubidoux, labeled site C in Figure 1, completed the complement of three ground stations. Site C is 50 miles east of downtown Los Angeles.

The three sites were selected to lie along the normal air trajectory eastward from Los Angeles. Due to their locations, the stations were expected to monitor polluted Los Angeles air at different stages of photochemical reaction and thereby improve understanding of the distribution and dynamics of photochemical pollutants.

Site A is in an area of high traffic density, site B is well removed from local emissions sources, and site C is located next to a highway. The Temple City station was most influenced by local emissions, and the Cable airport monitoring laboratory was least affected. The elevation of site B, at 1,450 feet, may have affected the measurements made there, especially in the morning. During the mornings of several study days, Cable Airport in Upland appeared to lie above the inversion layer. On these days the haze front was clearly observed moving eastward in the valleys in the late morning and early afternoon. This phenomenon is discussed later in the report.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San Bernardino
Riverside
C
Riverside
Fullerton
Corona
Torrance
Anaheim
Los Angeles
Orange
Riverside
Orange

Figure 1. Locations of three ground monitoring stations in the Los Angeles basin.

SECTION 4

EXPERIMENTAL METHODS

GROUND LEVEL MEASUREMENTS

The Los Angeles field program required three ground monitoring stations as well as an instrumented aircraft. The Battelle mobile laboratory, pictured in Figure 2, served as the base station and was located at Cable Airport in Upland, California. The mobile lab was used as a continuous ground monitoring station and as a support lab for aircraft and auxillary ground station operations. The location of the various ground stations was described in the previous section.

The variables measured at each of the three ground stations (Sites A-C), the measurement technique and the averaging interval are listed in Tables 1-3. At all three sites a high speed blower pulled sample air through a manifold. This manifold, in turn, supplied sample air to all instruments and the Tedlar bags (via a Metal Bellows Corp. pump) through short lengths of 1/4" Teflon tubing. Ground level measurements were made over an 8 hour daylight period, 0900 to 1700 PST. Details of the operation and calibration of the instruments listed in the tables have been presented elsewhere(1,2). Integrated Tedlar bag samples were collected at all sites and analyzed at the mobile lab within 2-3 hours for the species indicated in the tables. Before collection, each sampling bag was evacuated, tested for leaks and then backfilled twice with zero nitrogen and evacuated twice. This procedure ensured negligible contamination or carry over in the sample bags.

High volume aerosol samplers were operated 8 hours a day at each site using quartz fiber filters (Pallflex Corp.). The samplers were located on the roofs at sites A and C. The mobile lab (site B) samples were collected from 25 feet above ground by three 6-inch diameter aluminum stacks. At all sites pressure drop measurements were made at the beginning and end of each day's sampling to correct for day-to-day fluctuations in flow rate. Initial calibration of the blowers was done with a calibrated venturi.

At the mobile lab, one of the three high volume samplers was equipped with a specially designed cyclone which served as a collector for particles > 2.0 μm diameter. A quartz backup filter collected the aerosol in the smaller size range.

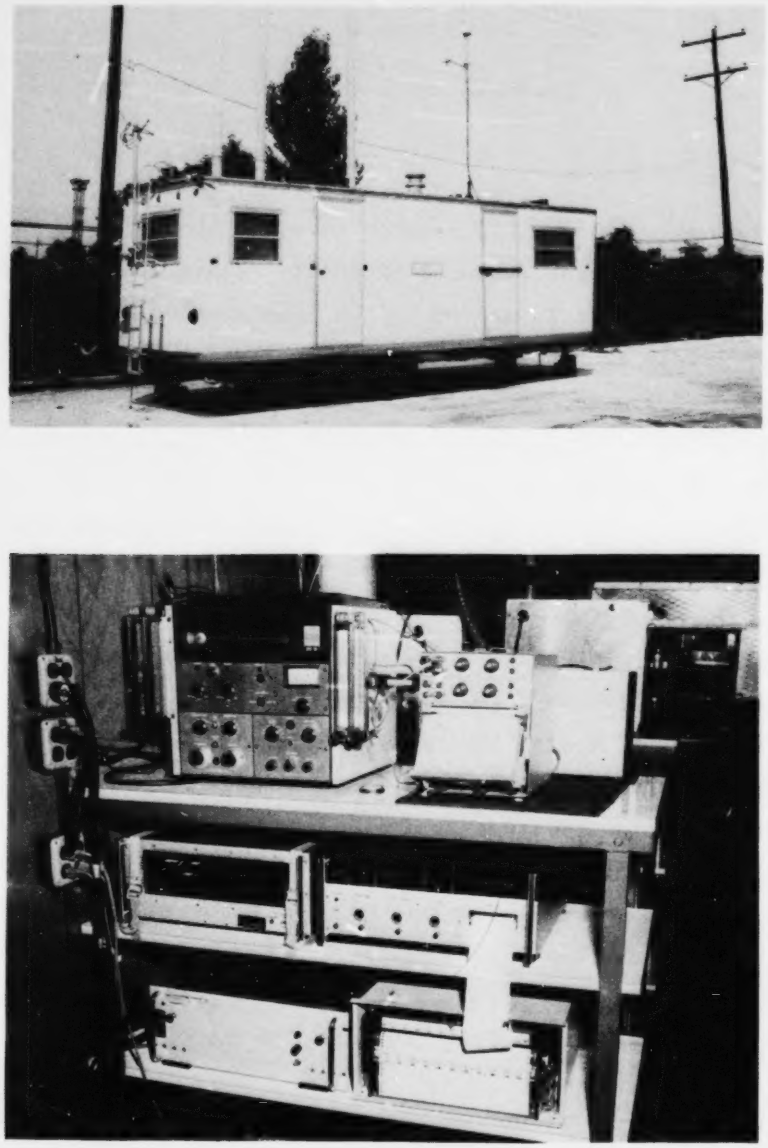


FIGURE 2. BATTELLE MOBILE AIR QUALITY LABORATORY

TABLE 1. MEASUREMENTS AT SITE A (Temple City)

Measured Variable	Averaging Interval	Technique	Instrument
O_3(a)	2-hr	U.V. Absorption	Dasibi 1003 AH
NO(a)	2-hr	Chemiluminescence	TECO 14B
NO_x(a)	2-hr	Chemiluminescence	TECO 14B
SO_2(b)	2-hr	Coulometric	Beckman 906A
$HONO_2$	2-hr	Coulometry	Battelle modified Mast
Fluorocarbon-11(c)	2-hr	Electron Capture G.C.	Varian 1200
PAN(c)	2-hr	Electron Capture G.C.	Varian 1200
NMHC(c)	2-hr	FID Gas Chromatography	Beckman 6800
CH_4(c)			
CO(c)			
C_2H_4(c)			
C_2H_2(c)			
NO_3^-	8-hr	HiVol/Ion Chromatography	D-ion-X Model 10
$SO_4^=$	8-hr	HiVol/Ion Chromatography	D-ion-X Model 10
NH_4^+	8-hr	HiVol/Gas Sensing Electrode	Orion NH_3
C,H,N	8-hr	HiVol/Combustion-Thermal Conductivity	Perkin-Elmer 240

(a) Data collected and provided by California Air Resources Board. The assistance of J. Holmes, J. Went, and J. Skousen is greatly appreciated.

(b) SO_2 data collected at Azusa by SCAPCD

(c) From 2-hr integrated bag samples which were returned to the Battelle mobile lab in Upland for analysis.

TABLE 2. MEASUREMENTS AT SITE B (Upland)

Measured Variable	Averaging Interval	Technique	Instrument
O_3	2-hr	Chemiluminescence	Bendix
NO	2-hr	Chemiluminescence	Bendix
NO_x	2-hr	Chemiluminescence	Bendix
SO_2	2-hr	Flame Photometric	Battelle built instrument
NH_3	2-hr	Dual Catalyst Chemiluminescence	Bendix 8101-B
$HONO_2$	2-hr	Coulometry	Battelle modified Mast
PAN[(a)]	2-hr	Electron Capture G.C.	Varian 1200
Fluorocarbon-11[(a)]	2-hr	Electron Capture G.C.	Varian 1200
NMHC[(a)]	2-hr	FID Gas Chromatography	Beckman 6800
CH_4[(a)]			
CO[(a)]			
C_2H_4[(a)]			
C_2H_2[(a)]			
Mass Loading	8-hr	HiVol/Weighing	Cahn Microbalance
NO_3^-	8-hr	HiVol/Ion Chromatograph	D-ion-X Model 10
$SO_4^=$	8-hr	HiVol/Ion Chromatograph	D-ion-X Model 10
NH_4^+	8-hr	HiVol/Gas Sensing Electrode	Orion NH_3
C,H,N	8-hr	HiVol/Combustion-Thermal Conductivity	Perkin-Elmer 240
Temperature	2-hr	Automated Weather Station	MRI Model 802
Relative Humidity	2-hr	Automated Weather Station	MRI Model 907
Wind Speed	2-hr	Automated Weather Station	MRI Model 1074-2
Wind Direction	2-hr	Automated Weather Station	MRI Model 1074-2
Global Radiation Intensity	2-hr	180° pyrheliometer	Eppley

(a) From 2-hr integrated bag samples

TABLE 3. MEASUREMENTS AT SITE C (Rubidoux)

Measured Variable	Averaging Interval	Technique	Instrument
O_3(a)	2-hr	U. V. Absorption	Dasibi 1003 AH
NO(a)	2-hr	Colorimetric	Beckman 911
NO_x(a)	2-hr	Colorimetric	Beckman 911
SO_2(a)	2-hr	Coulometric	Beckman 906A
$HONO_2$	2-hr	Coulometry	Battelle Modified Mast
PAN(b)	2-hr	Electron Capture G.C.	Varian 1200
Fluorocarbon-11(b)	2-hr	Electron Capture G.C.	Varian 1200
NMHC(b)	2-hr	FID Gas Chromatography	Beckman 6800
CH_4(b)			
CO(b)			
C_2H_4(b)			
C_2H_2(b)			
NO_3^-	8-hr	HiVol/Ion Chromatography	D-ion-X Model 10
$SO_4^=$	8-hr	HiVol/Ion Chromatography	D-ion-X Model 10
NH_4^+	8-hr	HiVol/Gas Sensing Electrode	Orion NH_3
C,H,N	8-hr	HiVol/Combustion Thermal Conductivity	Perkin-Elmer 240

(a) Data collected and provided by SCAPCD. The assistance of T. Hernandez is greatly appreciated.

(b) From 2-hr integrated bag samples which were returned to the Battelle mobile lab in Upland for analysis.

AIRCRAFT MEASUREMENTS

The aircraft employed for horizontal and vertical sampling during the Los Angeles studies was a twin-engine Cessna Skymaster. The aircraft is pictured in Figure 3. The aircraft was equipped to make the measurements listed in Table 4. Sample air for the instruments and the Tedlar bag collections entered the plane through a 3-port stainless steel sampling probe which was designed to replace an inspection port under the wing approximately 2/3 of the way from the cabin. The three sampling ports were connected to the continuous monitoring instruments and the bag filling station by individual 1/4'' Teflon tubes. Rapid sample air flow was obtained using ram flow in conjunction with an excess air vent just in front of the inlet to each monitor. Signals from the continuous monitors were recorded on two dual-pen strip chart recorders.

The Tedlar sampling bags were filled through a Teflon tube containing a variable orifice. Each bag was evacuated, tested for leaks, backfilled with zero-nitrogen, evacuated, backfilled, and evacuated again prior to loading aboard the aircraft for each flight. This procedure ensured negligible contamination of the sample bags. After collection the bags were kept in the dark and as cool as possible until analysis.

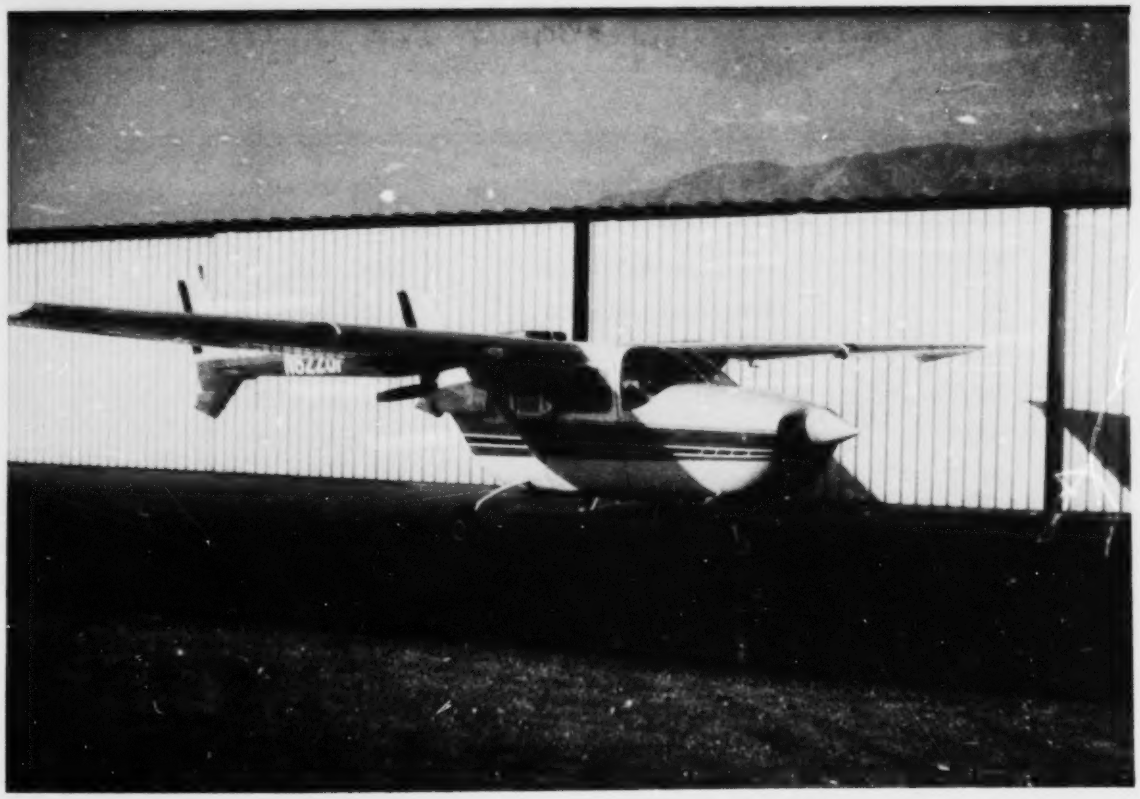


FIGURE 3. TWIN ENGINE AIRCRAFT USED FOR LOS ANGELES SAMPLING

TABLE 4. AIRCRAFT MEASUREMENTS DURING THE LOS ANGELES FIELD PROGRAM

Variable	Technique	Instrument
O_3	Chemiluminescence	REM, Inc.
NO_x	Chemiluminescence	TECO Model 14D
Temperature	Compensated Thermistor	NA
PAN(a)	Electron Capture G.C.	Varian 1200
NMHC(a)	FID Gas Chromatography	Beckman 6800
CH_4(a)	FID Gas Chromatography	Beckman 6800
C_2H_4(a)	FID Gas Chromatography	Beckman 6800
C_2H_2(a)	FID Gas Chromatography	Beckman 6800
CO(a)	FID Gas Chromatography	Beckman 6800
Fluorocarbon-11(a)	Electron Capture G.C.	Varian 1200

(a) From integrated samples collected in Tedlar bags.

SECTION 5

RESULTS

Summaries of the Los Angeles area ground station and aircraft data are presented in this section. Results from the three ground stations will be presented first, followed by the aircraft data.

GROUND MONITORING RESULTS

A detailed summary of the air quality data at Temple City, Upland and Rubidoux for the 22 days of field monitoring between October 15 and November 15, 1976, is given in Tables 5, 6, and 7. As described earlier, a two hour averaging period was employed for all gas phase and meteorological data to make the data comparable with the 2-hr integrated bag results. The gas phase data are shown in the tables as both 8-hour averages and maximum 2-hour averages. Aerosol mass loadings and dominant weather features for each day at Upland are shown in Table 6. The weather during the field program can be categorized as variable, with periods of hot, dry, desert (Santana) winds interspersed with warm, humid, hazy days more typical of summer conditions. Individual daily data tables which include both 2-hour results and 8-hour averages are included in Appendix A of this report. The symbol -1.0 in these tables indicates no data for that interval. A negative sign in front of any other table entry means that the number was derived through interpolation.

The results of 8-hour high volume sampling on high purity quartz fiber filters (Pallflex Corp., QAST) are listed in Table 8 for Temple City, Upland and Rubidoux. The filters were analyzed for nitrate, sulfate, ammonium and total nitrogen as described in the Experimental section. Total mass loading (TSP) values were shown earlier for Upland in Table 6.

Additional ground level meteorological and air quality data were obtained for several sites in the southcoast basin. Although these data are too voluminous for inclusion in this report, pertinent portions will be presented and discussed later in the report.

TABLE 5. SUMMARY OF AIR QUALITY DATA - SITE 1 (Temple City)

Date	Pollutants														
	8-Hour Average (0900-1700 PST)												2-Hour Maximum		
	O_3, ppm	NO, ppm	NO_x, ppm	SO_2, ppm	PAN, ppm	$HONO_2$, ppm	F-11, ppt	CO, ppm	NMHC, ppmC	CH_4, ppm	C_2H_2, ppmC	C_2H_4, ppmC	O_3, ppm	NO_x, ppm	PAN, ppm
10-15-76	.064	.006	.074	≤.005	.007	≤.006	846	3.14	-	3.11	.034	-	.115	.100	.010
10-18-76	.051	.014	.078	.011	≤.001	≤.006	421	2.80	-	2.43	.028	.090	.080	.105	.002
10-19-76	.054	.010	.108	.010	.003	≤.006	423	3.96	1.78	2.47	.045	.062	.095	.145	.006
10-20-76	.011	.061	.205	.020	≤.001	≤.006	424	5.85	2.38	3.01	.055	-	.020	.265	.002
10-21-76	.038	.010	.091	.010	.002	≤.006	547	3.09	1.44	2.32	.034	.087	.065	.100	.006
10-22-76	.014	.018	.076	≤.005	≤.001	≤.006	1194	2.42	1.32	2.03	.026	-	.025	.085	≤.001
10-25-76	.049	.008	.076	≤.005	.004	≤.006	2103	2.82	1.16	2.23	.039	.063	.075	.095	.008
10-26-76	.015	.010	.041	≤.005	-	≤.006	-	-	-	-	-	-	.020	.110	-
10-27-76	.019	.036	.124	≤.005	-	≤.006	-	-	-	-	-	-	.035	.175	-
10-28-76	.015	.036	.126	.006	≤.001	≤.006	1415	2.66	1.14	2.18	.041	.057	.030	.140	.001
10-29-76	.026	.033	.144	.020	.002	≤.006	728	3.13	1.41	2.32	.046	.059	.045	.190	.004
11-1-76	.028	.019	.093	.029	≤.001	≤.006	982	2.13	0.93	2.02	.033	-	.035	.140	.002
11-2-76	.033	.014	.085	.012	≤.001	≤.006	550	1.91	1.09	1.97	.027	.057	.045	.110	.001
11-3-76	.020	.023	.116	≤.005	≤.001	≤.006	841	2.68	1.27	2.05	.037	.075	.035	.180	.002
11-4-76	.033	.011	.068	≤.005	≤.001	≤.006	728	1.57	1.27	1.95	.028	.059	.055	.110	.004
11-5-76	.004	.016	.075	≤.005	≤.001	≤.006	513	1.87	0.85	1.91	.028	-	.010	.115	.002
11-8-76	.026	.011	.100	≤.005	.003	≤.006	832	2.19	1.25	2.10	.033	-	.045	.140	.010
11-9-76	.046	.029	.143	.025	.005	≤.006	1094	3.23	1.57	2.46	.044	.074	.075	.180	.010
11-10-76	.061	.018	.148	.027	.014	≤.006	929	3.96	2.00	2.77	.058	.077	.095	.215	.024
11-11-76	.008	.026	.075	.010	<.001	≤.006	482	2.11	0.93	2.14	.031	.057	.015	.105	≤.001
11-12-76	.004	.035	.080	.010	<.001	≤.006	337	1.93	0.86	2.05	.029	.043	.010	.110	≤.001
11-15-76	.016	.025	.109	.006	.002	≤.006	750	2.59	1.29	2.27	.039	.059	.030	.165	.005

TABLE 6. SUMMARY OF AIR QUALITY DATA - SITE 2 (CABLE AIRPORT, UPLAND)

	Weather Conditions				Pollutants														
					8-Hour Average (0900-1700 PST)											2-Hour Maximum		
Date	General[a]	Temp. °C[a]	R.H. %[b]	Aerosol Mass Loading, μg/m3	O_3, ppm	NO, ppm	NO_x, ppm	SO_2, ppm	PAN, ppm	$HONO_2$, ppm	F-11, ppt	CO, ppm	NMHC, ppmC	CH_4, ppm	C_2H_2, ppmC	C_2H_4, ppmC	O_3, ppm	NO_x, ppm	PAN, ppm
10-15-76	Warm, Haze	25.2	56	204.7	.201	.010	.032	≤.010	.023	≤.006	371	2.35	-	2.40	.022	-	.259	.053	.032
10-18-76	Warm, Haze	22.6	67	175.5	.125	≤.005	.038	.014	.017	≤.006	-	1.64	0.71	2.18	.007	-	.155	.046	.028
10-19-76	Warm, Haze	26.3	52	203.5	.148	≤.005	.061	.020	.019	≤.006	634	2.59	0.88	2.24	.025	.030	.195	.069	.040
10-20-76	Rain → Clear	25.1	45	219.2	.055	.019	.092	.016	.004	≤.006	-	2.93	0.77	2.18	.026	.034	.085	.151	.008
10-21-76	Warm, Haze	24.5	66	108.2	.121	≤.005	.033	.013	.005	≤.006	544	1.59	0.75	2.09	.015	.015	.163	.037	.008
10-22-76	Cloudy	21.4	70	77.9	.085	≤.005	.015	≤.010	≤.001	≤.006	325	1.06	0.51	1.91	.011	.016	.103	.023	.002
10-25-76	Warm, Haze	22.0	61	105.8	.108	.007	.019	≤.010	.019	≤.006	447	1.59	0.39	2.12	.016	.017	.145	.028	.024
10-26-76	Clear, Windy	23.5	27	179.3	.061	.005	.015	≤.010	≤.001	≤.006	225	.58	≤0.10	1.75	.004	.004	.073	.029	.002
10-27-76	Clear, Warm	24.3	22	82.3	.057	.009	.025	≤.010	≤.001	≤.006	265	.68	0.18	1.77	.010	.010	.072	.031	≤.001
10-28-76	Clear, Hot	25.8	22	78.0	.073	.011	.045	≤.010	.002	≤.006	274	.91	0.21	1.86	.012	.014	.099	.074	.006
10-29-76	Warm, Clear	23.2	30	99.2	.062	.011	.065	≤.010	.002	≤.006	297	1.33	0.43	1.92	.019	.019	.102	.110	.004
11-1-76	Clear, Hot	30.2	24	113.0	.064	.008	.050	≤.010	.001	≤.006	325	1.08	0.65	1.79	.015	.018	.072	.091	.001
11-2-76	Hot, Sunny	31.9	24	104.3	.071	.011	.050	≤.010	≤.001	≤.006	244	.73	0.40	1.74	.012	.017	.085	.113	.001
11-3-76	Clear, Hot	32.4	24	94.3	.066	.007	.042	≤.010	.001	≤.006	239	.80	0.27	1.78	.006	.009	.087	.059	.002
11-4-76	Clear, Hot	32.9	25	106.8	.048	.006	.026	≤.010	≤.001	≤.006	185	.57	0.30	1.79	.007	.011	.067	.064	≤.001
11-5-76	Sunny, Hot	31.5	25	73.2	.061	-	.026	≤.010	≤.001	≤.006	228	.69	0.16	1.69	.005	.010	.081	.052	.001
11-8-76	Sunny, Hot	30.3	26	68.8	.057	.007	.036	≤.010	≤.001	≤.006	311	.75	0.47	1.76	.007	.009	.072	.063	.002
11-9-76	Warm, Hazy	27.1	31	140.0	.110	.008	.068	≤.010	.008	≤.006	422	1.61	0.55	1.99	.019	.017	.188	.083	.018
11-10-76	Sunny, Hazy	23.9	43	160.0	.056	≤.005	.077	.015	.019	≤.006	544	2.04	1.15	2.21	.034	.033	.202	.095	.030
11-11-76	P. Cloudy, Hazy	17.4	68	106.2	.050	≤.005	.034	≤.010	.003	≤.006	370	1.20	0.42	1.91	.016	.021	.069	.058	.008
11-12-76	Overcast, Rain	16.5	81	39.2	.028	.010	.040	≤.010	≤.001	≤.006	213	.94	0.40	1.89	.014	.025	.059	.048	.001
11-15-76	Warm, Haze	21.8	52	73.4	.055	.016	.050	≤.010	.003	≤.006	227	1.10	0.57	2.03	.030	.030	.068	.063	.005

(a) Max, 2-Hour Avg.

(b) Avg.

TABLE 7. SUMMARY OF AIR QUALITY DATA - SITE 3 (RUBIDOUX)

	Pollutants														
	8-Hour Average (0900-1700 PST)												2-Hour Maximum		
Date	O_3, ppm	NO, ppm	NO_x, ppm	SO_2, ppm	PAN, ppm	$HONO_2$, ppm	F-11, ppt	CO, ppm	NMHC, ppmC	CH_4, ppm	C_2H_2, ppmC	C_2H_4, ppmC	O_3, ppm	NO_x, ppm	PAN, ppm
10-15-76	.119	≤.005	.040	.015	.006	≤.006	715	1.50	-	2.39	.010	-	.160	.055	.010
10-18-76	.096	≤.005	.028	.017	.003	≤.006	-	1.10	-	2.15	.017	-	.115	.030	.008
10-19-76	.105	≤.005	.079	.020	.009	≤.006	1219	1.86	1.05	2.25	.018	.038	.155	.125	.016
10-20-76	.043	.006	.105	.011	.003	≤.006	-	2.55	1.13	2.37	.025	.053	.070	.180	.006
10-21-76	.088	≤.005	.053	.018	.004	≤.006	798	1.36	0.80	2.09	.007	-	.100	.070	.006
10-22-76	.053	≤.005	.046	≤.005	≤.001	≤.006	656	.94	0.97	1.98	.009	-	.065	.055	.002
10-25-76	.108	≤.005	.053	.013	.005	≤.006	490	1.20	0.79	2.06	.014	.012	.135	.085	.008
10-26-76	.030	≤.005	.020	≤.005	≤.001	≤.006	275	.69	0.48	1.67	.006	-	.030	.025	≤.001
10-27-76	.030	.010	.037	≤.005	≤.001	≤.006	238	.45	0.33	1.74	.003	-	.030	.045	≤.001
10-28-76	.028	-	.054	≤.005	≤.001	≤.006	162	.56	0.28	1.76	.005	-	.030	.110	≤.001
10-29-76	.061	≤.005	.043	.011	.002	≤.006	344	.90	0.49	1.92	.013	.028	.080	.105	.004
11-1-76	.031	≤.005	.030	≤.005	≤.001	≤.006	292	1.03	0.39	1.73	.016	.035	.045	.130	≤.001
11-2-76	.022	.014	.051	≤.005	≤.001	≤.006	195	.87	0.44	1.75	.012	-	.035	.120	≤.001
11-3-76	.030	.013	.080	≤.005	≤.001	≤.006	274	1.11	0.86	1.80	.013	-	.045	.110	≤.001
11-4-76	.025	≤.005	.023	≤.005	≤.001	≤.006	210	.72	0.51	1.70	.007	-	.035	.075	≤.001
11-5-76	.033	.008	.033	≤.005	≤.001	≤.006	212	1.32	0.72	1.74	.016	-	.045	.105	≤.001
11-8-76	.043	.019	.050	≤.005	≤.001	≤.006	307	.76	0.63	1.79	.017	-	.060	.145	.001
11-9-76	.086	.010	.057	.015	.005	≤.006	510	1.30	0.85	2.14	.020	-	.150	.105	.011
11-10-76	.114	.008	.043	.028	.009	≤.006	525	1.17	0.64	2.11	.017	.031	.145	.100	.017
11-11-76	.050	≤.005	.021	.010	.004	≤.006	417	.89	0.46	1.94	.013	.026	.060	.050	.006
11-12-76	.015	.015	.060	≤.005	≤.001	≤.006	365	.96	0.47	1.88	.017	.022	.025	.060	≤.001
11-15-76	.029	≤.005	.020	≤.005	≤.001	≤.006	162	.43	0.17	1.68	.006	.016	.030	.020	≤.001

TABLE 8. HIGH VOLUME SAMPLING RESULTS (μg/m3)
FOR 0900-1700 PST AT THREE SITES

Date	Temple City				Upland				Rubidoux			
	NO_3^-	$SO_4^=$	NH_4^+	Tot. N	NO_3	$SO_4^=$	NH_4^+	Tot. N	NO_3^-	$SO_4^=$	NH_4^+	Tot. N
10/15/76	1.76	32.4	8.6	8.1	1.6	36.9	10.2	7.2	26.58	33.9	16.4	25.9
10/18/76	1.03	33.1	8.2	7.8	0.36	36.2	11.6	9.0	3.26	31.9	10.8	12.4
10/19/76	1.58	31.9	5.8	6.1	1.2	32.1	10.8	7.9	47.19	32.5	13.8	26.8
10/20/76	2.25	18.8	3.7	4.6	2.3	18.0	7.1	4.8	44.48	19.1	11.2	23.5
10/21/76	1.81	18.5	3.2	4.7	0.82	18.4	6.7	2.8	3.36	17.3	3.8	4.8
10/22/76	1.66	11.1	1.5	1.6	0.49	12.1	3.4	2.7	1.90	16.5	3.8	4.3
10/25/76	1.88	12.4	2.4	2.9	0.78	19.8	4.8	4.7	6.41	16.6	6.0	8.6
10/26/76	1.83	3.7	0.36	1.1	2.1	3.6	0.56	1.8	0.82	1.8	0.07	0.8
10/27/76	1.78	3.0	0.45	1.2	0.52	1.4	0.09	0.5	0.42	1.4	0.07	0.2
10/28/76	1.82	3.3	0.60	1.0	1.9	2.7	0.35	1.1	1.01	1.5	<0.02	0.3
10/29/76	4.34	6.2	1.6	2.4	2.9	5.2	0.98	1.6	5.47	2.8	0.49	2.4
11/1/76	1.32	4.3	1.0	1.3	1.7	3.4	0.52	1.1	1.43	2.1	0.10	0.9
11/2/76	1.11	2.1	0.32	0.8	1.6	3.8	0.45	1.5	0.96	1.6	<0.02	0.2
11/3/76	0.91	1.7	0.26	0.1	1.1	3.2	0.15	0.9	1.22	1.4	<0.02	0.2
11/4/76	0.89	1.5	0.21	0.5	1.1	1.9	0.30	0.8	0.64	1.3	<0.02	0.2
11/5/76	1.19	3.5	0.35	0.6	0.98	4.1	0.48	0.8	0.72	1.5	<0.02	0.3
11/8/76	1.85	5.0	0.92	1.6	0.82	5.6	0.98	1.2	4.34	4.5	0.43	2.6
11/9/76	2.51	8.6	2.9	3.7	3.1	9.2	1.9	3.5	17.10	9.7	5.3	13.1
11/10/76	1.66	18.2	4.6	5.2	2.3	18.1	4.3	4.8	13.76	13.4	5.5	13.0
11/11/76	2.84	10.6	2.0	2.5	1.9	11.6	2.2	2.1	3.02	11.3	2.1	3.4
11/12/76	2.34	4.2	0.32	0.5	1.3	5.2	0.34	0.6	4.10	5.2	0.35	0.5
11/15/76	1.88	6.2	1.2	1.5	3.0	5.6	0.75	1.8	0.39	0.69	<0.02	0.1
Average	1.83	10.9	2.3	2.7	1.5	11.7	3.1	2.9	8.57	9.9	3.65	5 05

AIRCRAFT SAMPLING RESULTS

In all, forty-two aircraft sampling flights of varying duration were undertaken during the 22 days of the field program. Maps showing the flight pattern and the geographical location of each integrated bag sample are included in Appendix B of this report. Two maps are shown for each flight; one displaying the O_3 concentrations along the flight path and the other the NO and NO_x concentrations. Heavy shading along a portion of the flight path indicates collection of a bag sample. Vertical profiles taken during the flights are also included in Appendix B.

Results of the analyses of the bag samples for each flight are listed in Table 9. The tabulated flight and bag numbers are keyed to the flight maps in Appendix B. Missing data are listed in the table as -1.0. The NO_x data shown in Table 9 were obtained by averaging the instrument signal over the same time interval as the bag samples. The concentrations of the other species reported in Table 9 result from analysis of the bag samples at the mobile lab at Cable Airport. Most bags were analyzed within 1-2 hours of collection. Decay of PAN in the darkened bags was found to be minimal over these short times, in agreement with the results of Lonneman and Bufalini(3). The thermal decomposition of PAN undoubtedly is minimized by the high NO_2/NO ratios of the samples.

TABLE 9. LOS ANGELES AIRPLANE BAG DATA

DATE	FLIGHT BAG	PAN PPM	F-11 PPT	CO PPM	NOX PPM	CH4 PPMC	C2H4 PPMC	C2H2 PPMC	NMHC PPMC
10-20-76	1-1	.005	-1.	2.40	-1.000	2.32	.035	.024	.96
10-20-76	1-2	≤ .001	-1.	.75	-1.000	1.82	.005	.004	≤ .10
10-21-76	2-1	.005	-1.	1.40	.072	2.00	.016	.010	2.20
10-21-76	2-2	.005	-1.	.86	.050	1.95	.012	.006	1.45
10-21-76	2-3	.011	634.	1.66	.050	2.12	.016	.015	1.48
10-21-76	3-1	.003	529.	1.40	.065	1.95	.041	.014	2.25
10-21-76	3-2	.003	306.	1.70	.065	1.96	.020	.016	.95
10-21-76	3-3	.005	490.	-1.00	.065	-1.00	-1.000	-1.000	-1.000
10-21-76	3-4	.004	396.	1.20	.065	1.90	.015	.009	1.34
10-25-76	5-1	.003	436.	1.20	.085	1.98	.020	.018	1.13
10-25-76	5-2	.017	673.	2.02	.122	2.32	.021	.025	.93
10-25-76	5-3	-1.000	-1.	-1.00	.064	-1.00	-1.000	-1.000	-1.00
10-25-76	5-4	.013	529.	1.04	.081	2.05	.009	.012	.57
10-25-76	6-1	.011	594.	1.40	.113	2.21	.030	.015	.87
10-25-76	6-2	.005	529.	1.24	.085	1.91	.038	.017	.97
10-25-76	6-3	.018	806.	1.40	.088	2.00	.010	.013	3.83
10-25-76	6-4	.016	727.	1.72	.098	2.21	.040	.020	1.02

TABLE 9. (Continued)

DATE	FLIGHT BAG	PAN PPM	F-11 PPT	CO PPM	NOX PPM	CH4 PPMC	C2H4 PPMC	C2H2 PPMC	NMHC PPMC
10-29-76	13-1	.003	479.	.82	.048	1.89	.018	.009	1.80
10-29-76	13-2	.004	353.	1.29	.079	1.95	.020	.017	.93
10-29-76	13-3	≤ .001	216.	.60	.071	1.83	.009	.003	.77
10-29-76	13-4	≤ .001	266.	.65	.086	1.85	.012	.010	.76
10-29-76	14-1	≤ .001	270.	.75	.052	1.88	.018	.007	.46
10-29-76	14-2	.002	436.	1.05	.067	2.02	.020	.013	.62
10-29-76	14-3	.003	238.	.80	.049	1.88	.012	.009	.20
10-29-76	14-4	≤ .001	396.	.65	.055	1.86	.017	.015	.89
11-01-76	15-1	≤ .001	230.	.16	.013	1.68	≤ .002	≤ .002	.25
11-01-76	15-2	≤ .001	349.	.86	.074	1.91	.012	.011	1.31
11-01-76	15-3	≤ .001	216.	.30	.024	1.60	≤ .002	≤ .002	.40
11-01-76	15-4	≤ .001	299.	.45	.042	1.75	.011	.009	.57
11-01-76	16-1	≤ .001	313.	.66	.048	1.83	.005	.005	.34
11101-76	16-2	.007	662.	2.08	.105	2.09	.024	.027	1.39
11-01-76	16-3	.003	382.	.83	.051	1.83	.018	.010	.47
11-01-76	16-4	.003	630.	1.20	.080	1.93	.017	.015	1.83

TABLE 9. (Continued)

DATE	FLIGHT BAG	PAN PPM	F-11 PPT	CO PPM	NOx PPM	CH4 PPMC	C2H4 PPMC	C2H2 PPMC	NMHC PPMC
10-26-76	7-1	≤ .001	187.	.30	.014	1.65	≤ .002	≤ .002	.43
10-26-76	7-2	≤ .001	227.	.28	.014	1.61	.004	≤ .002	.26
10-26-76	7-3	≤ .001	331.	.25	.011	1.67	≤ .002	≤ .002	.66
10-26-76	7-4	≤ .001	475.	.24	.011	1.68	.003	≤ .002	1.52
10-26-76	8-1	≤ .001	223.	.31	.023	1.64	≤ .002	.004	≤ .10
10-26-76	8-2	≤ .001	173.	.46	.011	1.69	.003	≤ .002	≤ .10
10-27-76	9-1	≤ .001	518.	.80	.051	1.90	.015	.018	1.75
10-27-76	10-1	≤ .001	371.	.80	.045	1.86	.007	.009	.46
10-27-76	10-2	≤ .001	252.	.25	.012	1.73	.004	≤ .002	≤ .10
10-27-76	10-3	≤ .001	266.	.21	.012	1.72	≤ .002	≤ .002	.20
10-28-76	11-1	≤ .001	133.	.43	.022	1.80	.020	.009	.11
10-28-76	11-2	.003	364.	1.40	.096	2.02	.020	.023	.70
10-28-76	11-3	≤ .001	166.	.19	.012	1.73	≤ .002	≤ .002	≤ .10
10-28-76	11-4	≤ .001	396.	.27	.017	1.77	≤ .002	≤ .002	1.03
10-28-76	12-1	.007	547.	1.38	.088	2.17	.017	.018	.81
10-28-76	12-2	.006	475.	1.15	.073	2.08	.020	.019	.57
10-28-76	12-3	.003	101.	.20	.018	1.78	≤ .002	≤ .002	≤ .10
10-28-76	12-4	.005	475.	1.24	.104	2.21	.015	.019	.91

TABLE 9. (Continued)

DATE	FLIGHT BAG	PAN PPM	F-11 PPT	CO PPM	NOX PPM	CH4 PPMC	C2H4 PPMC	C2H2 PPMC	NMHC PPMC
11-02-76	17-1	≤ .001	223.	.40	.033	1.69	.010	.006	.79
11-02-76	17-2	≤ .001	662.	.70	.054	1.70	.015	.010	2.70
11-02-76	17-3	≤ .001	166.	.10	.015	1.65	.009	.004	.45
11-02-76	17-4	≤ .001	270.	.40	.038	1.72	≤ .002	≤ .002	.58
11-02-76	18-1	≤ .001	205.	.58	.040	1.75	.011	≤ .002	.31
11-02-76	18-2	≤ .001	353.	1.00	.057	1.85	.011	.009	.66
11-02-76	18-3	≤ .001	230.	.20	.020	1.70	.005	≤ .002	.33
11-02076	18-4	≤ .001	184.	.40	.031	1.70	.014	.005	.17
11-03-76	19-1	≤ .001	230.	.40	.033	1.75	.010	.006	.38
11-04-76	20-1	≤ .001	230.	.66	.060	2.23	.015	.009	.42
11-04-76	20-2	≤ .001	1141.	3.30	.225	2.15	.050	.054	2.72
11-04-76	21-1	≤ .001	252.	.10	.012	1.63	.005	≤ .002	.47
11-04-76	21-2	≤ .001	360.	.83	.077	1.82	.011	.012	.70
11-04-76	21-3	≤ .001	155.	.10	.012	1.65	.004	≤ .002	.14
11-04-76	21-4	≤ .001	162.	.14	.021	1.62	≤ .002	≤ .002	.23

TABLE 9. (Continued)

DATE	FLIGHT BAG	PAN PPM	F-11 PPT	CO PPM	NOX PPM	CH4 PPMC	C2H4 PPMC	C2H2 PPMC	NMHC PPMC
11-04-76	22-1	≤ .001	306.	.50	.025	2.26	.012	.005	1.04
11-04-76	22-2	≤ .001	432.	.50	.022	1.95	.003	.003	1.55
11-04-76	22-3	.002	266.	.60	.051	1.76	.018	.009	.34
11-04-76	22-4	.006	432.	1.82	.100	1.89	.021	.027	.32
11-05-76	23-1	≤ .001	2020.	5.70	.350	2.88	.076	.081	2.79
11-05-76	23-2	≤ .001	313.	1.08	.100	3.18	.020	.012	.87
11-05-76	24-1	≤ .001	414.	.80	.050	1.95	.010	.010	.85
11-05-76	24-2	.020	1055.	4.38	.275	3.30	.057	.052	3.05
11-05-76	24-3	.031	1300.	5.70	.325	3.50	.072	.091	3.93
11-05-76	25-1	.008	796.	2.90	.165	2.52	.035	.040	1.81
11-05-76	25-2	.004	763.	1.25	.090	1.93	.028	.026	1.55
11-08-76	26-1	.006	464.	1.30	.060	1.97	.018	.015	1.80
11-08-76	26-2	.013	266.	1.40	.060	2.19	.012	.023	.03
11-08-76	26-3	.018	382.	2.25	.090	2.05	.035	.033	3.29
11-08-76	26-4	≤ .001	518.	2.23	.300	2.05	.033	.032	1.55

TABLE 9. (Continued)

DATE	FLIGHT BAG	PAN PPM	F-11 PPT	CO PPM	NOX PPM	CH4 PPMC	C2H4 PPMC	C2H2 PPMC	NMHC PPMC
11-08-76	27-1	≤ .001	313.	.64	.068	1.80	.010	.008	.48
11-08-76	27-2	.005	828.	1.58	.142	2.04	.038	.020	1.41
11-08-76	27-3	.004	497.	1.13	.055	2.02	.010	.013	1.24
11-09-76	28-1	≤ .001	238.	.52	.015	1.82	.011	.014	≤ .10
11-09-76	28-2	.003	306.	.69	.048	1.89	.010	.006	.29
11-09-76	28-3	≤ .001	331.	.59	.033	1.79	.010	.008	≤ .10
11-09-76	28-4	.003	331.	.69	.038	2.06	.012	.007	.39
11-09-76	29-1	.005	446.	1.04	.067	2.00	.011	.012	.55
11-09-76	29-2	.010	968.	1.80	.108	2.17	.040	.022	1.43
11-09-76	29-3	.003	497.	.73	.050	1.96	.025	.013	.82
11-09-76	29-4	.006	587.	.86	.060	2.01	.013	.010	.49
11-09-76	30-1	.007	497.	1.25	.071	2.04	.014	.017	1.66
11-09-76	30-2	.005	331.	1.10	.092	2.00	.010	.017	.97
11-09-76	30-3	.011	644.	1.35	.085	2.07	.042	.016	2.35
11-09-76	30-4	.005	464.	.93	.047	1.99	.030	.014	1.59

TABLE 9. (Continued)

DATE	FLIGHT BAG	PAN PPM	F-11 PPT	CO PPM	NOX PPM	CH4 PPMC	C2H4 PPMC	C2H2 PPMC	NMHC PPMC
11-10-76	31-1	.010	367.	1.40	.056	2.05	.015	.017	.80
11-10-76	31-2	.004	324.	1.25	.070	2.00	.015	.012	.57
11-10-76	31-3	.005	382.	.85	.035	1.80	.020	.011	.64
11-10-76	31-4	.006	281.	.86	.041	1.90	.015	.012	.42
11-10-76	32-1	.010	497.	1.65	.141	2.30	.030	.021	1.18
11-10-76	32-2	.017	680.	2.57	.150	2.45	.040	.033	2.05
11-10-76	32-3	.010	382.	.95	.078	1.99	.015	.008	.83
11-10-76	32-4	.012	-1.	1.20	.072	2.25	.026	.013	1.07
11-10-76	33-1	.013	662.	2.15	.170	2.39	.041	.030	1.41
11-10-76	33-2	.018	695.	1.80	.103	2.30	.038	.026	1.33
11-10-76	33-3	.011	464.	1.30	.085	2.10	.035	.019	.68
11-10-76	33-4	.013	893.	1.80	.113	2.40	.038	.025	1.45
11-11-76	34-1	≤ .001	205.	.40	.027	1.86	.008	.004	.20
11-11-76	34-2	≤ .001	263.	.70	.052	1.89	.010	.011	.28
11-11-76	34-3	.004	256.	.85	.050	1.90	.006	.010	.33
11-11-76	34-4	.003	230.	.65	.037	2.02	.008	.008	.35

TABLE 9. (Continued)

DATE	FLIGHT BAG	PAN PPM	F-11 PPT	CO PPM	NOX PPM	CH4 PPMC	C2H4 PPMC	C2H2 PPMC	NMHC PPMC
11-11-76	35-1	≤ .001	151.	.30	.016	1.75	.010	.005	.36
11-11-76	35-2	.002	230.	1.35	.067	1.66	.015	.015	1.06
11-11-76	35-3	≤ .001	230.	.45	.031	1.67	.025	.005	.51
11-12-76	36-1	≤ .001	230.	.65	.041	1.85	.020	.007	4.05
11-12-76	36-2	≤ .001	263.	.70	.045	1.80	.018	.008	4.70
11-12-76	36-4	≤ .001	230.	.63	.045	1.80	.024	.011	3.42
11-15-76	37-1	≤ .001	130.	.50	.020	1.85	.014	.010	.75
11-15-76	37-2	≤ .001	133.	.55	.041	1.89	.010	.006	.33
11-15-76	37-3	≤ .001	115.	.25	.014	1.70	.010	≤ .002	.40
11-15-76	37-4	≤ .001	162.	.30	.023	1.75	.015	.007	.67
11-15-76	38-1	≤ .001	299.	.70	.059	1.92	.028	.015	.68
11-15-76	38-2	.002	396.	1.4[illegible]	.105	1.98	.025	.019	.97
11-15-76	38-3	.002	976.	.22	.015	1.66	.005	.004	.15
11-15-76	38-4	≤ .001	198.	.60	.042	1.80	.012	.005	.38
11-15-76	39-1	.002	274.	.90	.050	1.90	.015	.012	.70
11-15-76	39-2	.007	828.	1.67	.110	2.25	.036	.023	1.28
11-15-76	39-3	≤ .001	115.	.14	.015	1.63	.005	≤ .002	≤ .10
11-15-76	39-4	.002	331.	.88	.052	1.91	.015	.018	.42

TABLE 9. (Continued)

DATE	FLIGHT BAG		PAN PPM	F-11 PPT	CO PPM	NOX PPM	CH4 PPMC	C2H4 PPMC	C2H2 PPMC	NMHC PPMC
11-16-76	40-1	≤	.001	976.	3.40	.225	3.20	.083	.050	2.98
11-16-76	40-2	≤	.001	1037.	4.10	.337	5.40	.070	.063	5.80
11-16-76	40-3	≤	.001	810.	3.90	.375	4.95	.060	.053	4.45
11-16-76	41-1		.005	382.	1.27	.065	2.00	.018	.016	.90
11-16-76	41-2		.007	644.	2.10	.125	2.60	.038	.033	1.97
11-16-76	41-3		.004	490.	1.03	.100	1.98	-1.000	-1.000	.70
11-16-76	42-1	≤	.001	205.	.23	.020	1.89	.011	.005	.61
11-16-76	42-2		.005	331.	1.33	.050	2.12	.020	.020	.08
11-16-76	42-3	≤	.001	335.	2.40	.250	2.00	.450	.036	1.00
11-16-76	42-4	≤	.001	187.	.53	.192	1.74	.015	.005	.26

SECTION 6

ANALYSIS AND INTERPRETATION

Analysis of the Los Angeles basin data has two objectives; first to define the distribution and disposition of nitrogen oxides and second, to study the movement of pollutants, specifically O_3, through the basin. The first part of this section will focus on composite results from the three ground stations. The remainder of the section will be devoted to discussion of a limited number of individual experiments on a case study basis.

ANALYSIS OF GROUND STATION DATA

The air quality data for individual study days at all three ground stations are tabulated in Appendix A and summarized in Tables 5-7. To provide a feeling for the data trends at each site, the composite profiles of several selected gases are plotted in Figures 4-6 for Temple City, Upland and Rubidoux, respectively. The composites include all of the study data, from October 15, 1976 to November 15, 1976, averaged over each 2-hour sampling interval. The 2-hour averages are plotted at the midpoint of the sampling period.

The composite profiles show that O_3 reached its maximum value during the same time interval, 13:00-15:00 PST, at all three sites, although the maximum concentrations differ significantly at the three stations. Both secondary pollutants O_3 and PAN reached the highest values at Upland. Nitric oxide concentrations decreased during most of the day at all three sites, but increased later in the afternoon at Temple City. This increase of NO has an obvious effect on reducing late afternoon O_3 at this site. Such an increase was also observed for NO_x and CO, and is probably associated with the onset of evening rush hour traffic. The afternoon increases in CO and NO_x were much less distinct at Upland and Rubidoux. The concentrations of CO and NO_x were higher throughout the day at Temple City compared to the other sites. This undoubtedly reflects the proximity of the site to dense emissions areas.

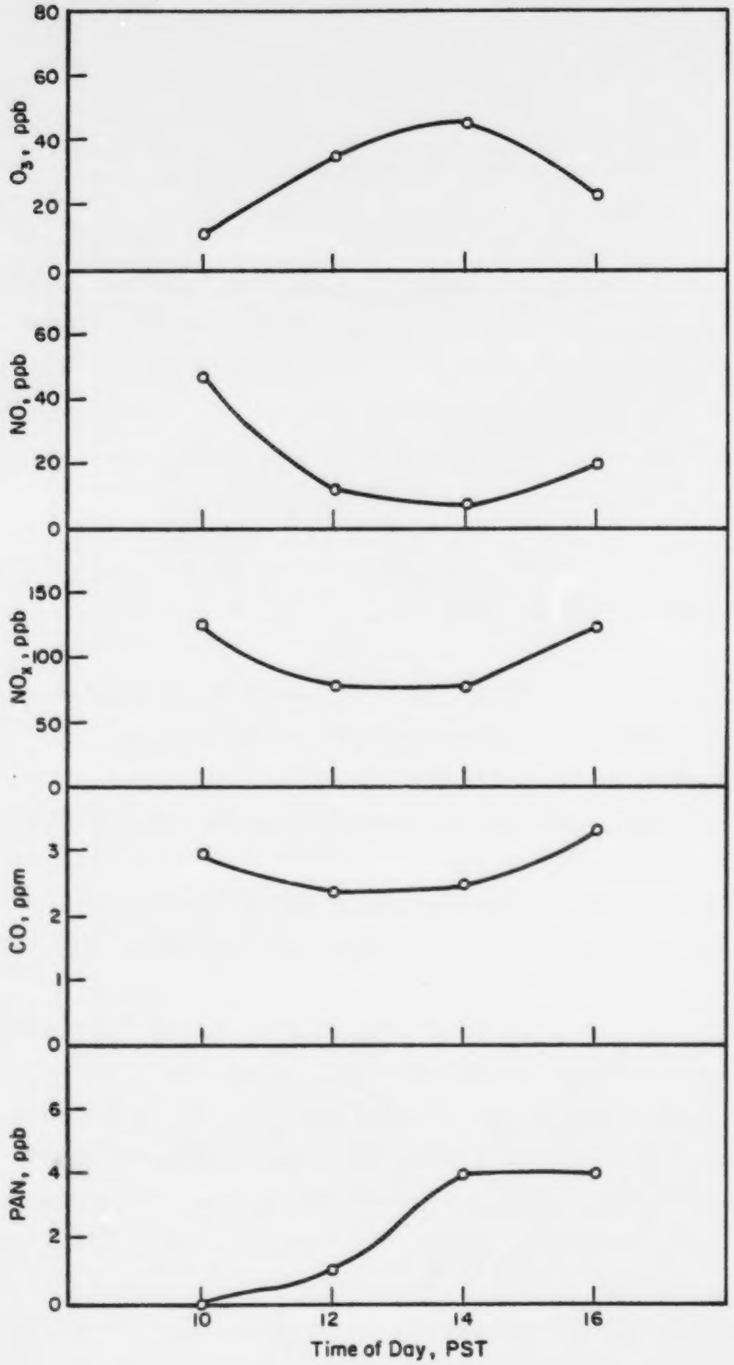


Figure 4. Composite profiles for Temple City.

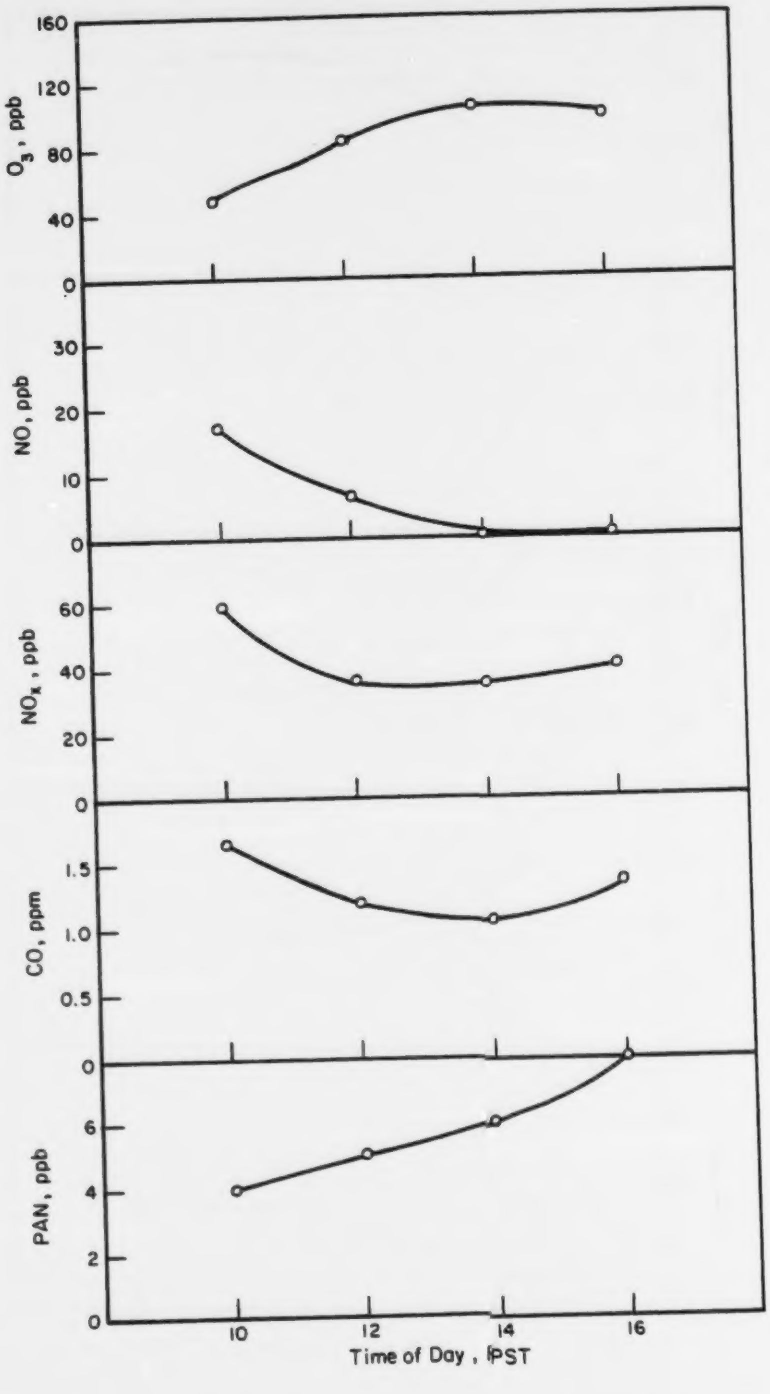


Figure 5. Composite Profiles for Upland.

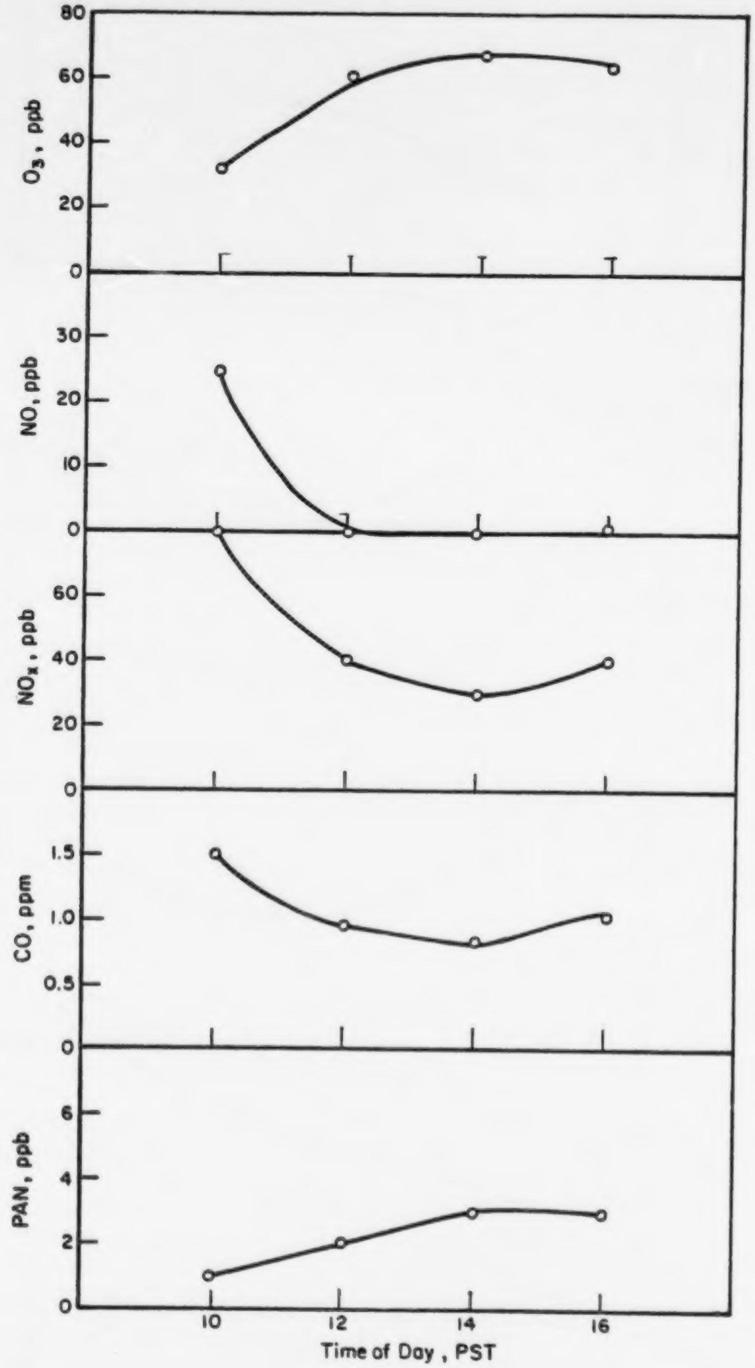


Figure 6. Composite profiles for Rubidoux.

The composite profiles show that the highest levels of PAN were observed at Upland. Particularly surprising are the relatively high concentrations observed early in the morning. There is some evidence to suggest that the higher elevation of this site occasionally caused the monitoring station to lie above the morning inversion, and thus monitor pollutants trapped aloft from the previous days irradiation. This phenomenon will be discussed later in the report.

The day-to-day trends in the concentrations of O_3, NO_x, PAN and particulate nitrate are shown in Figures 7, 8, and 9 for the three sites. The maximum daily 2-hour average is plotted for O_3, NO_x, and PAN. The particulate nitrate results are 8-hour averages over the period 0900-1700 PST. In general the trends in O_3, NO_x, and PAN are similar at all three sites. Ozone levels were relatively high at all three sites on October 15, 18, 19, 21, 25, and November 9 and 10. PAN concentrations were also high on most of these days. Most of the remaining days exhibited only minimal smog manifestations due to Santana winds or rain.

Particulate nitrate concentrations at Rubidoux tracked PAN almost exactly and also followed O_3 closely. The nitrate levels at Rubidoux were generally much higher than at the other stations. Nitrate at Upland seems better correlated with NO_x than PAN, while Temple City nitrate did not track any of the other variables particularly well. It should be emphasized that the particulate nitrate values reported here are largely artifact-free. A study of artifact nitrate was conducted in Upland simultaneously with this program, and the results have been reported elsewhere(4,5).

Based on the trend data from Figures 7-9, as well as meteorological information, a subset of the most interesting sampling days has been selected. October 14, 18-22, 29 and November 9-11 were chosen as the most appropriate days for analysis, and much of the ensuing discussion will focus on these days.

Carbon monoxide and acetylene were monitored during the study because they are relatively inert and can serve as tracers of air mass dilution. The ratio of CO to C_2H_2 in automotive exhaust has been reported by Kopczynski, et al.,(6) to be 60.4 in Los Angeles (freeway underpass samples) and 67.2 in New York (Lincoln tunnel). The ratio averaged 48 in downtown

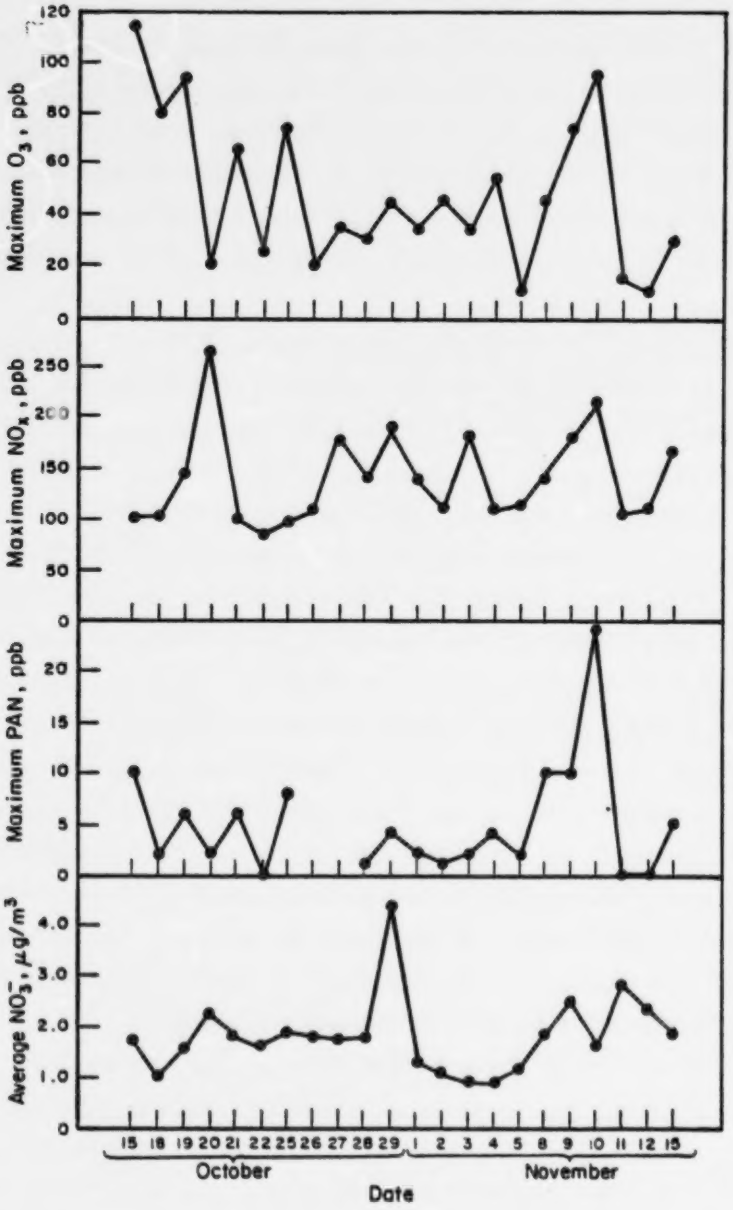


Figure 7. Trends in selected pollutants at Temple City.

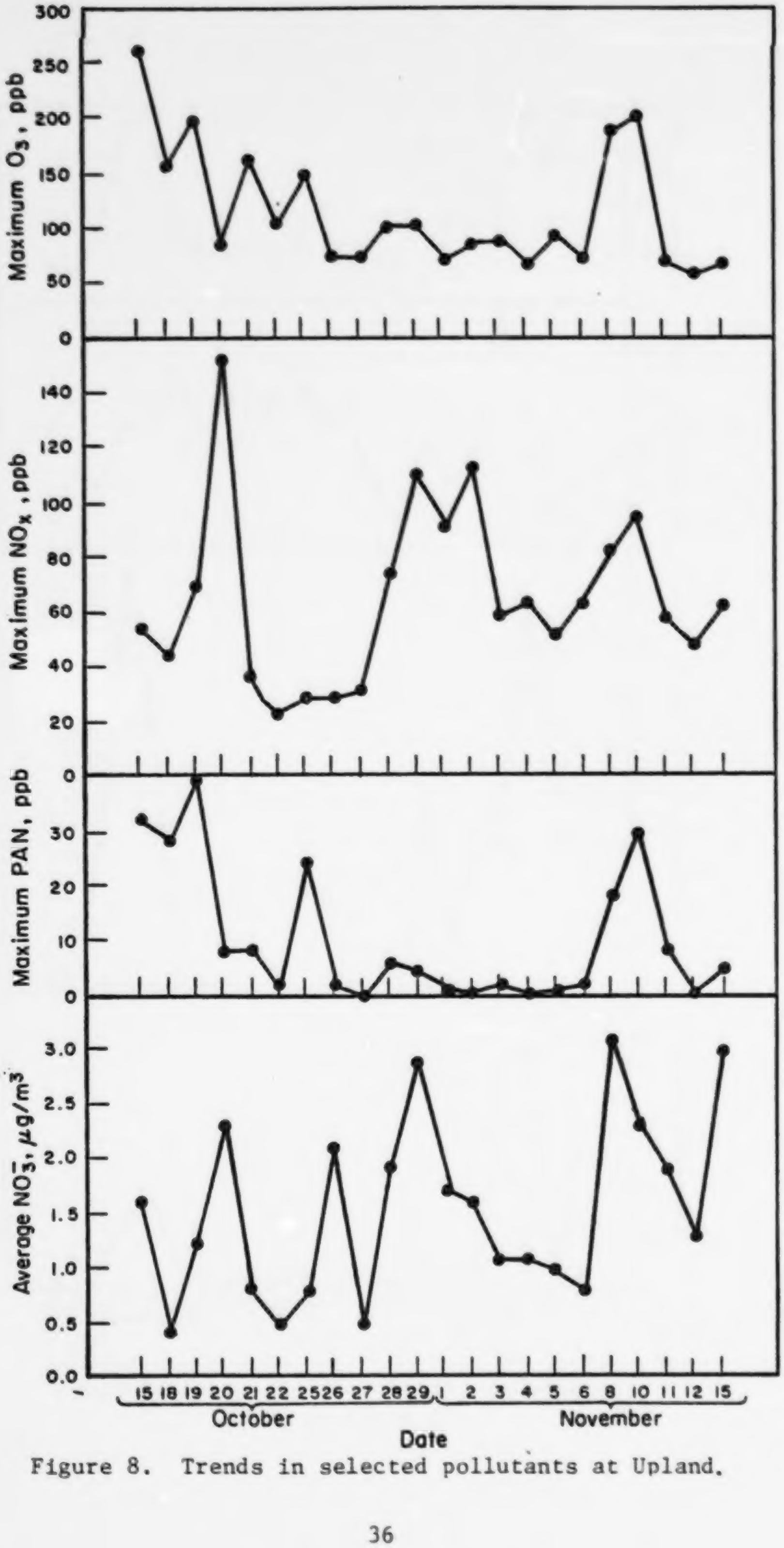


Figure 8. Trends in selected pollutants at Upland.

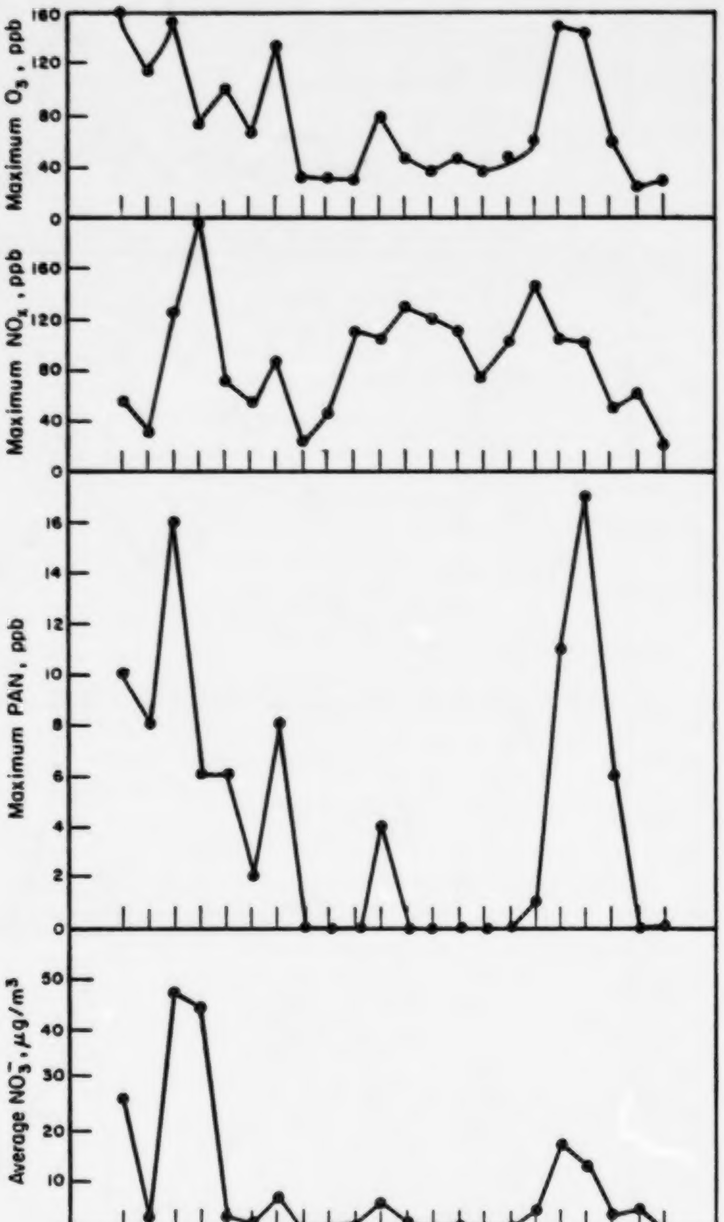


Figure 9. Trends in selected pollutants at Rubidoux.

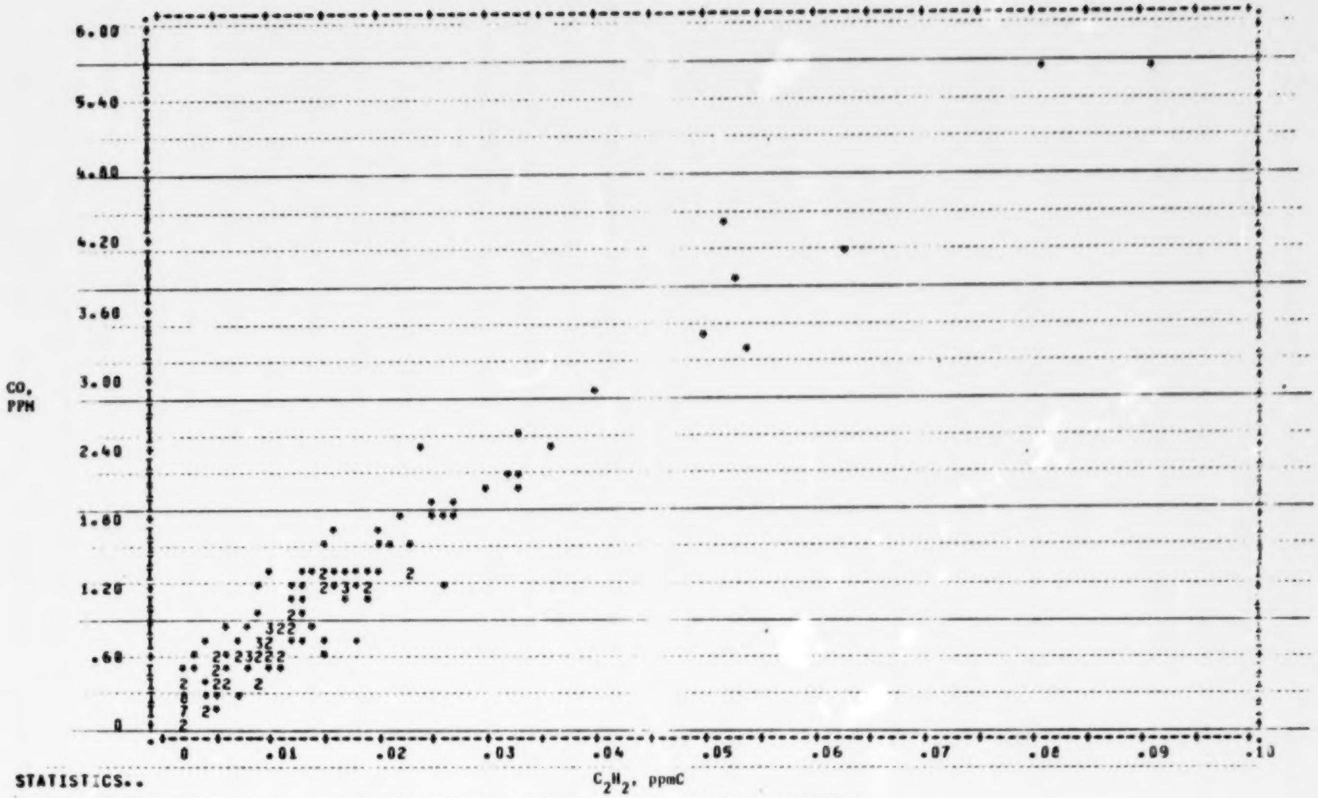
St. Louis air, and 90 in non-urban samples. Regression analysis of the ground and aircraft data from this study yields the CO to C_2H_2 ratios shown in Table 10. The regression plot for the aircraft results is shown in Figure 10. These values fall within the range reported for urban air and automotive exhaust.

TABLE 10. CO/C_2H_2 FROM REGRESSION ANALYSIS

	CO/C_2H_2	R
Temple City	66	0.80
Upland	54	0.70
Rubidoux	45	0.70
Aircraft Results	66	0.97

The strong correlation between CO and C_2H_2 at all sites suggests that they derive from a similar source, most likely vehicular exhaust. For purposes of this report it will be assumed that automotive emissions are responsible for all the C_2H_2 and all but a small (~0.15 ppm) geochemical background amount of the CO.

The data collected at the ground stations permit an estimate of the fraction of the nonmethane hydrocarbon burden attributable to auto exhaust. The ground station auto exhaust contributions shown in Table 11 are derived using acetylene as a tracer for automobile exhaust, and the reported(7) C_2H_2/NMHC ratio for exhaust. In parentheses are shown the auto exhaust contributions reported by Mayrsohn, et al.,(7) for communities nearest each of the ground sites. The results are reasonably consistent considering that the data sets were collected in different years and at different locations. In general, the average automotive contribution to the overall hydrocarbon burden (excluding methane) was near 50 percent at each of the ground stations.



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STATISTICS..
  CORRELATION (R)-            .97306      R SQUARED      -        .94685
                                          INTERCEPT (A)  -        .15[illegible]5
                                          SLOPE (B)      -      65.62402
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Figure 10. Regression analysis of aircraft results for CO and C_2H_2.

TABLE 11. FRACTION OF HYDROCARBON BURDEN (NMHC) ATTRIBUTED TO AUTOMOBILE EXHAUST (0900-1700 PST)

Site	$\frac{\text{Auto Exhaust HC}}{\text{NMHC}}$
Temple City	0.54 (0.54 El Monte)
Upland	0.59 (0.65 Upland)
Rubidoux	0.41 (0.56 Redlands)

Ground Level Aerosol Results

Quartz fiber high volume filter samples were collected for 8-hours (0900-1700 PST) each day at all three ground stations and subsequently analyzed for nitrate, sulfate, ammonium and total nitrogen. The results of these analyses were shown earlier in Table 8. At Upland, where daily TSP results are available, nitrate comprised 1.3 percent, sulfate 9.8 percent and ammonium 2.6 percent of the total mass on the average. Eliminating the days of desert (Santana) winds, nitrate makes up 1.1 percent, sulfate 13.6 percent and ammonium 4.0 percent of the total mass on the remaining 11 relatively polluted days.

The data from Table 8 suggest a rather uniform distribution of sulate throughout the basin and a strong east-west gradient in particulate nitrate concentrations, in agreement with the ACHEX results(8). The sulfate and nitrate trends are pictured in Figures 11 and 12 for each of the three ground stations. The sulfate concentrations at the three sites track one another quite well. Nitrate concentrations, shown in Figure 12, are generally low at Temple City and Upland when compared with Rubidoux. The high nitrate days at Rubidoux will be discussed in detail in a subsequent section of this report.

The molar aerosol ratios for each site are presented in Table 12. The $NH_4^+ / SO_4^=$ ratios averaged 1.0 at Temple City and Upland and were almost always less than the 2.0 representative of $(NH_4)_2SO_4$. In contrast, the ratio frequently exceeded 2.0 Rubidoux. The excess NH_4^+ is most likely contributed by NH_4NO_3, since nitrate was present in high concentrations in

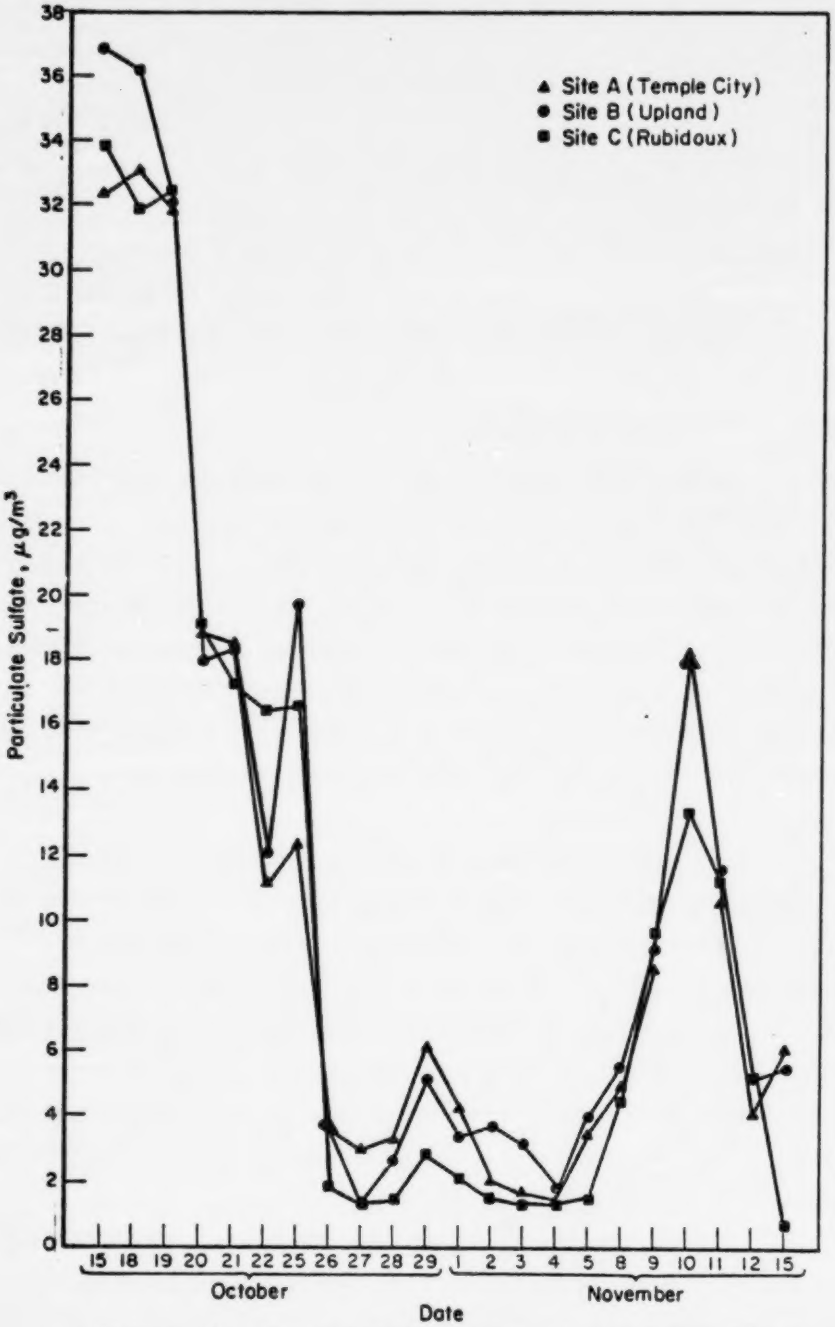

Figure 11. Daily trends in ground station sulfate.

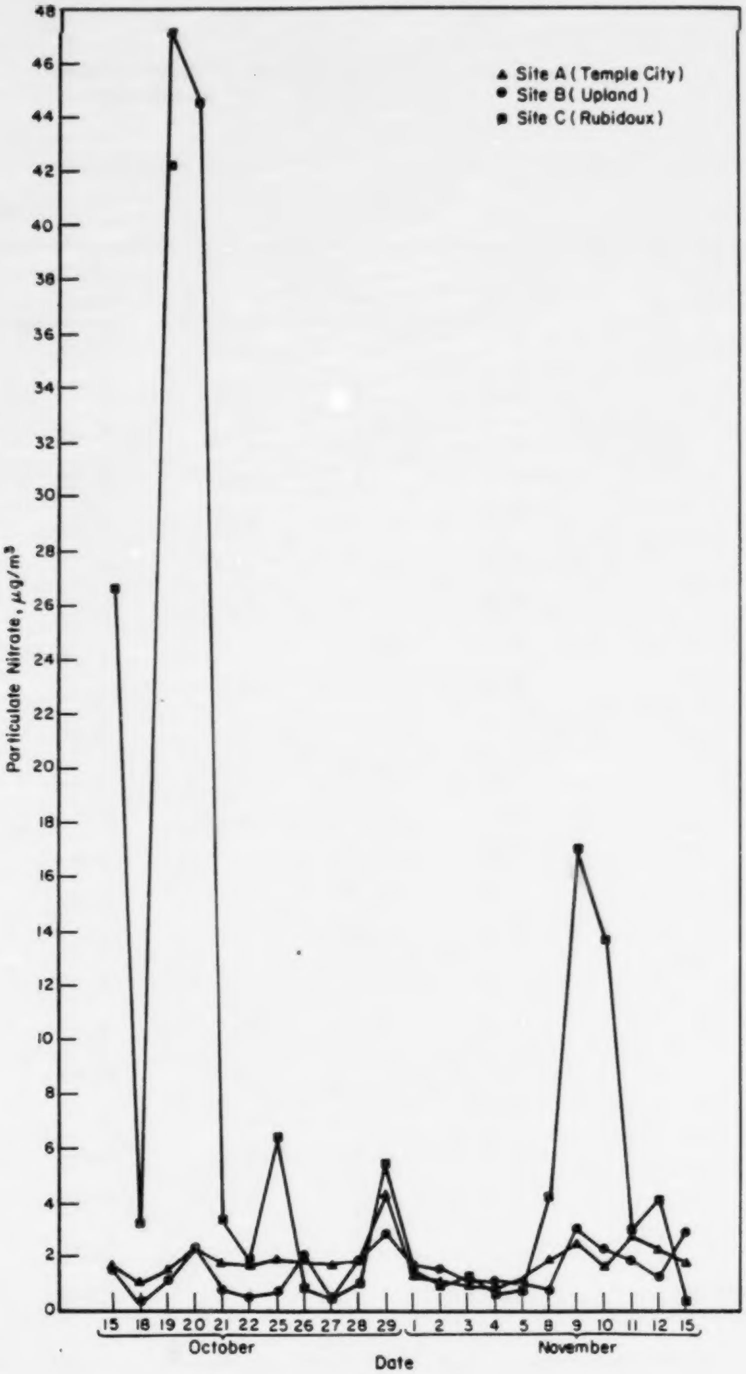

Figure 12. Daily trends in ground station nitrate.

TABLE 12. AEROSOL RATIOS (MOLAR) FROM LOS ANGELES FIELD PROGRAM

Date	$NH_4^+/SO_4^=$			$NO_3^-/SO_4^=$		
	Temple City	Upland	Rubidoux	Temple City	Upland	Rubidoux
10/15	1.4	1.5	2.6	0.08	0.07	1.21
10/18	1.3	1.7	1.8	0.05	0.02	0.16
10/19	1.0	1.8	2.3	0.08	0.06	2.25
10/20	1.0	2.1	3.1	0.18	0.20	3.60
10/21	0.9	1.9	1.2	0.15	0.07	0.30
10/22	0.7	1.5	1.2	0.23	0.06	0.18
10/25	1.0	1.3	1.9	0.23	0.06	0.60
10/26	0.5	0.8	0.2	0.76	0.90	0.71
10/27	0.8	0.3	0.3	0.92	0.58	0.46
10/28	1.0	0.7	-	0.85	1.09	1.04
10/29	1.4	1.0	0.9	1.08	0.86	3.02
11/1	1.2	0.8	0.2	0.48	0.77	1.05
11/2	0.8	0.6	-	0.82	0.65	0.93
11/3	0.8	0.2*	-	0.83	0.53	1.35
11/4	0.8	0.8	-	0.92	0.90	0.76
11/5	0.5	0.6	-	0.53	0.37	0.74
11/8	1.0	0.9	0.5	0.57	0.23	1.49
11/9	1.8	1.1	2.9	0.45	0.52	2.73
11/10	1.4	1.3	2.2	0.14	0.20	1.59
11/11	1.0	1.0	1.0	0.41	0.25	0.41
11/12	0.4	0.3	0.4	0.86	0.39	1.22
11/15	1.0	0.7	-	0.47	0.83	0.88
Avg. Daily Ratios	1.0	1.0	1.4	0.69	0.44	1.21

* Questionable value.

these samples. The correlation between NH_4^+ and $SO_4^=$ was extremely high, with coefficients exceeding 0.94 at all three ground stations. Such strong correlation is suggestive of chemical association between the ammonium and sulfate.

On the days when clean desert winds prevailed throughout the basin, the measured concentrations of the aerosol constituents were low and not highly accurate. On these days, the ratios can be greatly in error.

The $NO_3^-/SO_4^=$ ratios from Table 12 are quite variable and are generally less than 1.0 at Temple City and Upland. However, the high nitrate levels at Rubidoux frequently drive the ratio above 1.0 and occasionally above 3.0. The $NO_3^-/SO_4^=$ ratios will be discussed further in conjunction with the interpretation of nitrogen mass balance and conversion rates.

Aerosol Nitrogen Balance--

The fraction of total aerosol nitrogen which can be accounted for by NH_4^+-N and NO_3^--N is shown for each site in Table 13. Samples with total nitrogen concentrations less than 1 $\mu g/m^3$ are likely to be in error since this approaches the equivalent filter nitrogen background. This occurred often during days when Santana winds prevailed. These results have been eliminated from Table 13. The average aerosol nitrogen balance ranged from 70 percent in Rubidoux to 85 percent at Upland. These values are in the same range as New York, St. Louis, West Covina and Dayton(9). In all of these cities about 20 percent of the aerosol nitrogen can not be accounted for as ammonium or nitrate. The identity of the remaining nitrogen compounds is unknown, although previous work has shown that they are not nitrites(1). The aerosol nitrogen balance for the small particle collections ($\leq$ 2.0 μm) was excellent, averaging 97 percent. This suggests that the unidentified nitrogen may reside in the large particle size fraction.

Particle Size--

The mobile laboratory at Upland was equipped with a high volume sampler modified to include a cyclone with a 50 percent cut point at 2.0 μm. Particles having aerodynamic diameters less than 2.0 μm were collected behind the cyclone on quartz fiber filters. Except for the cyclone, this sampler was identical to the one whose results were just

TABLE 13. AEROSOL NITROGEN BALANCE ($\frac{NO_3^- - N + NH_4^+ - N}{\text{Total N}}$ x 100)

Date	Temple City	Cable Airport	Rubdioux
10/15	87	115	72
10/18	85	101	74
10/19	80	96	80
10/20	74	126	80
10/21	62	-	77
10/22	96	102	79
10/25	79	83	71
10/26	63	51	-
10/28	88	64	-
10/29	93	89	67
11/1	83	72	-
11/2	62	47	-
11/3	-	-	-
11/4	-	-	-
11/5	-	-	-
11/8	71	79	51
11/9	76	62	61
11/10	76	80	57
11/11	88	102	68
11/12	-	93	-
11/15	91	70	-
	79 ± 11%	85 ± 22%	70 ± 9%

discussed. The nitrate, sulfate and ammonium results from the total and small particle collections are pictured in Figure 13. The shaded portion of the bargraph represents the small particle concentration. There is an obvious error in the ammonium data, since the small particle NH_4^+ concentration exceeds the total aerosol NH_4^+ concentration on several days. On the average, 47 percent of the nitrate, 90 percent of the sulfate and nearly 100 percent of the ammonium was observed in the small particle size range. There is a clear correspondence in the $SO_4^=$ and NH_4^+ trends, as discussed earlier. This is expected if ammonium and sulfate are chemically associated. In contrast, the nitrate trend follows neither sulfate nor ammonium. Nor does the ratio of small particle/total nitrate bear much relationship to sulfate levels. The relationship of particulate nitrate to gaseous precursors and to other NO_x reaction products will be discussed in later sections of this report dealing with chemical conversion rates and mechanisms.

Distribution of Nitrogen Compounds at the Ground Stations

Based on the subset of 11 sampling days, the distribution of trace oxidized nitrogen* at the three ground stations was:

	Temple City	Upland	Rubdioux
NO	21 ppb (19%)	5 ppb (10%)	$\leq$5 ppb -
NO_2	87 ppb (78%)	33 ppb (66%)	41 ppb (78%)
PAN	3 ppb (3%)	11 ppb (22%)	5 ppb (10%)
$HONO_2$	$\leq$6 ppb (-)	$\leq$6 ppb (-)	$\leq$6 ppb (-)
NO_3^-	0.8 ppb (1%)	0.6 ppb (1%)	6.1 ppb (12%)

The percentage of total nitrogen which each species accounts for is shown in parenthesis. The average sum of trace nitrogen compounds is similar at Rubidoux and Upland and more than twice as high at Temple City.

Of the measured reaction products, the PAN contribution is greatest at Upland (22%) and the particulate nitrate contribution greatest at Rubidoux (12%). The fraction of oxidized nitrogen existing as reaction products was similar at Upland and Rubidoux, at 23 percent and 22 percent, respectively,

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* Excluding N_2O

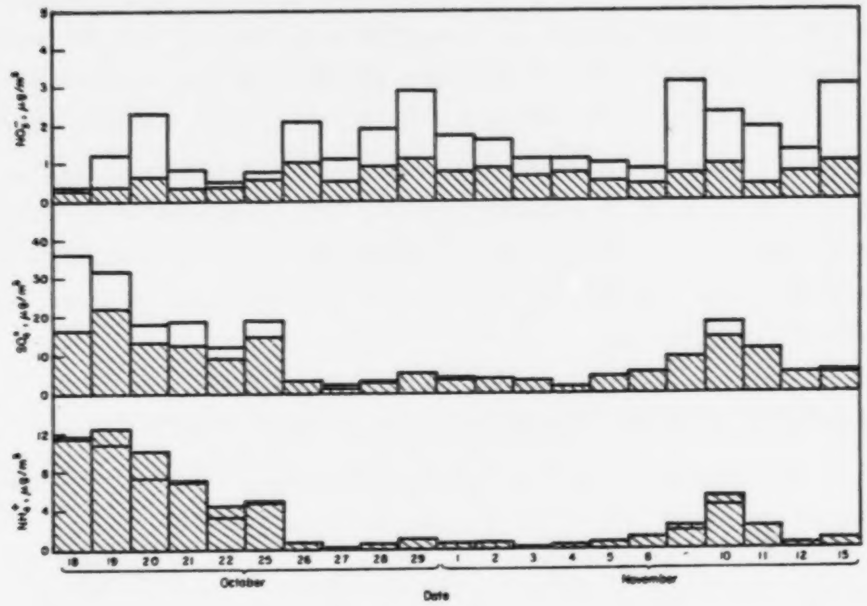

Figure 13. Total and small particle aerosol results for Upland. Shaded area represents particles ≤ 2.0 μm diameter.

although the product distribution was quite different at the two sites. Only about 4 percent of the nitrogen was found as reaction products at Temple City. The higher conversion percentages at Upland and Rubidoux are consistent with the longer reaction times along the trajectories from the source area to these sites. Another factor in the low Temple City percentages is high local NO_x emissions, which lower the reaction product/NO_x ratio. That this ratio should be very sensitive to the location of the monitoring site is obvious. Additional perspective may be gained by comparing distributions from other areas. In Table 14, the contribution of each compound to the total oxidized nitrogen burden is listed for several locations. Data from the same 8-hour daylight period was used for each location in the table except for the particulate nitrate entries for St. Louis and West Covina (L.A. Basin), where only 24-hour values were available. Data from each location have been averaged over at least four weeks of sampling.

The daily distribution ratio, F_N, defined as the fraction of measured oxidized nitrogen made up of reaction products (i.e., $\frac{PAN + NO_3^-}{NO + NO_2 + PAN + NO_3^-}$), is shown for each site in Figure 14.* With the exception of Upland on October 25, the trends in F_N are similar at the three sites. An error in the NO_x measurement on October 25 is suspected, since aircraft data taken in the vicinity of Upland showed much higher levels of NO_x than the ground monitor. Except for October 25 at Upland, the distribution ratio tracks daily O_3 (shown earlier in Figure 29) quite well at all three sites, as expected for photochemically derived pollutants.

It would be useful to compare diurnal trends in F_N at the sites, but short term particulate nitrate data are not available. Alternatively, the composite $\frac{PAN}{NO + NO_2 + PAN}$ ratios for the three sites are plotted in Figure 15. The patterns for Temple City and Rubidoux are similar, with maxima occurring in early afternoon. Such behavior has been observed in earlier studies(1) in St. Louis and West Covina. The Upland ratio is relatively high throughout the daylight sampling period. The high ratio of PAN to oxidized nitrogen in the morning is particularly surprising. A review of the 2-hour data shows that only 5 of the 22 sampling days exhibited high morning concentrations of PAN, but that these 5 days account for nearly half of the data (11 days) used to derive Figure 15. The higher elevation of

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* $HONO_2$ was generally not observed above the 6 ppb detection limit of the instrument used in this 1976 study. Since $HONO_2$ is measured as NO_2 by the chemiluminescence analyzer used for NO/NO_x analysis, it is included in the denominator of the ratio, and the reported values of F_N are actually lower limits.

TABLE 14. OXIDIZED NITROGEN DISTRIBUTION AT SEVERAL LOCATIONS
(Percent of Total)

	St. Louis (1973)	West Covina (1973)	Phoenix (1977)	Temple City	Upland	Rubidoux
NO	33	23	45	19	10	--
NO_2	45	57	51	78	66	78
PAN	9	13	2	3	22	10
$HONO_2$	12	6	--	--	--	--
NO_3^-	1	0.5	2	1	1	12

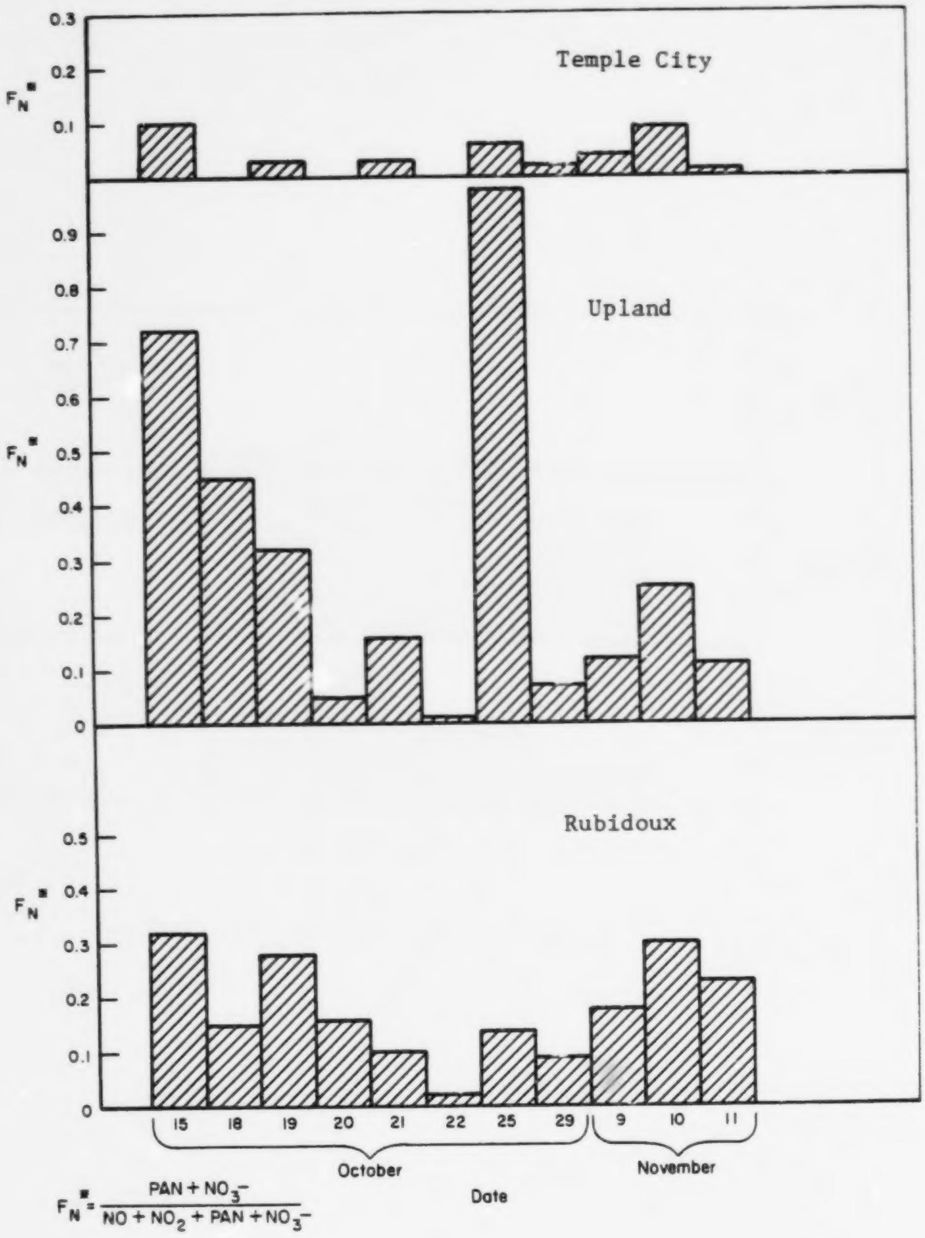

Figure 14. Daily trends in F_N.

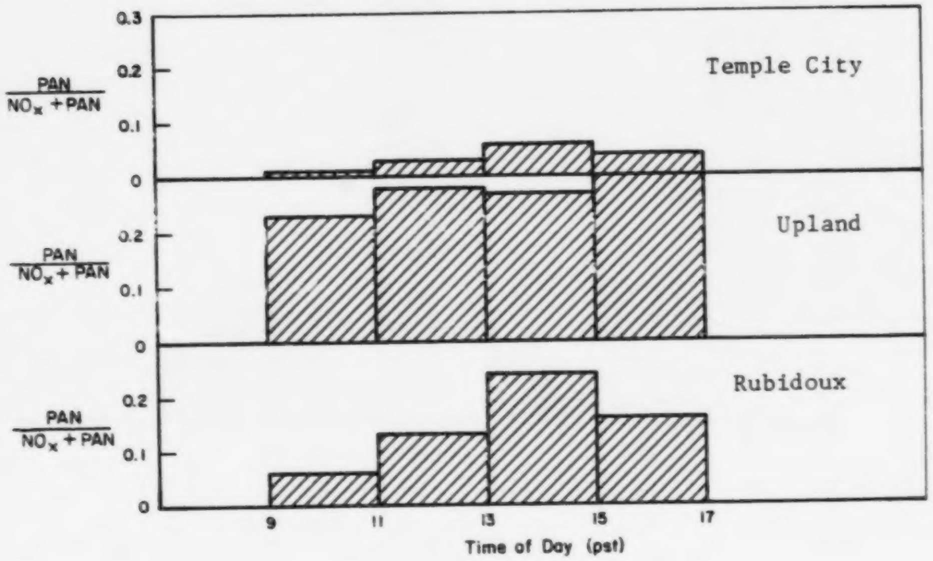

Figure 15. Composite Diurnal PAN/(NO_x+PAN) Ratios.

the Cable site (1450' MSL) may have resulted in sampling aged or reacted air above the morning inversion on at least some of these 5 days. This phenomenon may partly explain the high morning ratio, and it will be discussed later with regard to individual case study days.

Nitrogen - Sulfur Relationships

There has been much debate over differences between measured $SO_4^=/NO_3^-$ ratios and SO_2/NO_x emissions ratios. In the Los Angeles basin, for example, the ratio of SO_2 to NO_x emissions averages 0.2(10). Particulate sulfate and nitrate have been considered to be the final products of SO_2 and NO_x reactions, but the $SO_4^=/NO_3^-$ ratio averages about 2.0*. In fact, the ratio is even higher when inert filters are employed to minimize collection of artifact nitrate. For the 11 selected days of this study, the ratio ranged from 8.2 at Upland to 0.77 at Rubidoux. Values at all three sites were well above the 0.2 SO_2/NO_x emissions ratio.

The cause of the discrepancy became apparent when recent studies(1,9) demonstrated that the major initial NO_x reaction products are PAN and $HONO_2$. The measured $SO_4^=/NO_3^-$ ratios have always appeared too high because much of the nitrate was in the gas phase and was not measured. Table 15 summarizes the appropriate ratios for the selected days of the study period. The table shows the $SO_4^=/NO_3^-$ ratios to be much higher than the 0.2 SO_2/NO_x emissions ratio. When gaseous nitrate (PAN) is included in the denominator, the more eastern sites approach the emissions ratio much more closely. The higher ratio at Temple City may reflect the fact that a great deal of NO_x is emitted locally and has not yet reacted, whereas part of the SO_2 emitted by point sources near the coast already has been transformed to $SO_4^=$ by the time it reaches Temple City. The locations of the primary emissions sources in the basin are shown in Figure 16.

TABLE 15. AVERAGE MOLAR RATIOS OF SULFUR TO NITROGEN FOR 11 SELECTED DAYS

	Temple City	Upland	Rubidoux
$SO_4^=/NO_3^-$	5.8	8.2	0.77
$SO_4^=/(NO_3^- + PAN)$	1.2	0.42	0.42
$\frac{SO_2 + SO_4^=}{NO_x + PAN + NO_3^-}$	0.15	0.30	0.36

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* Values in 1966 and 1967 for five Los Angeles sites ranged from 1.8 to 2.3.

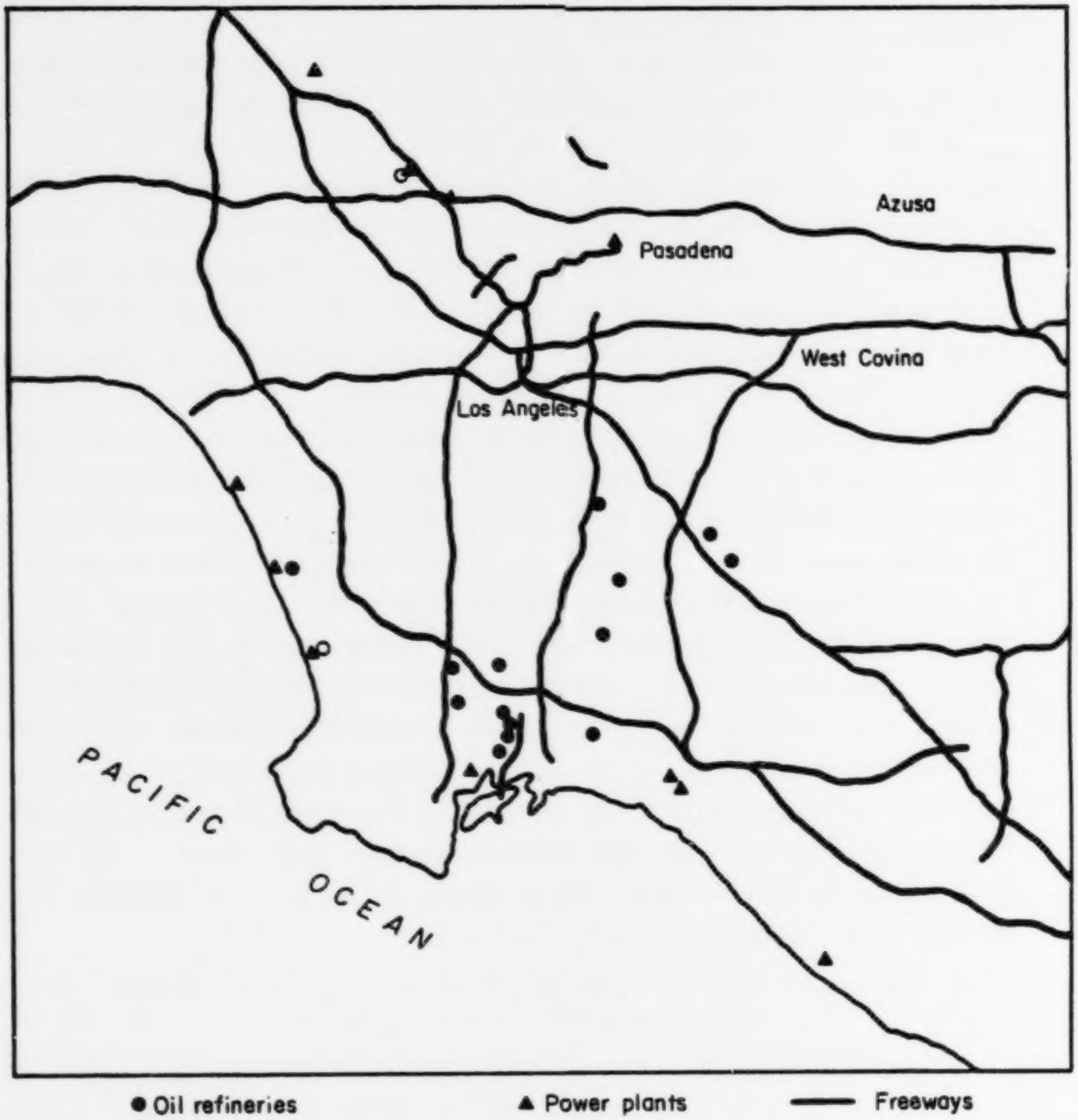
Azusa
Pasadena
West Covina
Los Angeles
PACIFIC
OCEAN
● Oil refineries
▲ Power plants
Freeways

Figure 16. Locations of primary sources in the Los Angeles basin.

When all of the measured sulfur and nitrogen species are taken into account,* the ratio $\frac{SO_2 + SO_4^=}{NO_x + PAN + NO_3^-}$ ranges from 0.15 at Temple City to 0.36 at Rubidoux, bracketing the emissions ratio. The fact that the measured ratios are similar to the emissions ratio suggests that the major sulfur and nitrogen species are being measured. Discussion of the nitrogen mass balance will be continued in the next section.

The nitrate to sulfate ratios in precipitation samples have been observed to exceed the aerosol $NO_3^-/SO_4^=$ ratios determined by high volume sampling in the L.A. Basin(11) and New York state(12). This observation is consistent with this study's finding that much of the ambient nitrate is in the gas phase.

Nitrogen Mass Balance

Comparison of the sulfur/nitrogen ratios in the previous section provided some confidence that the important nitrogen species are being taken into account. Other gaseous constituents also can be employed to test the nitrogen mass balance. Carbon monoxide, C_2H_2 and F-11 are all relatively inert and can be used to predict the NO_x concentrations in air parcels if the starting ratio of the tracer gas to NO_x is known. Emissions inventory data have been used in earlier studies to define the "unreacted" $\frac{\text{tracer}}{NO_x}$ ratios. Combination of the measured tracer concentration with the tracer/NO_x source ratios yields a prediction of the concentration of NO_x that would be present in the air parcel if only dilution had occurred.

Equation I is used to predict the downwind NO_x concentrations which would be present if no chemical or physical loss of NO_x occurs:

$$\frac{(\text{tracer})_{\text{measured}}}{\left(\frac{\text{tracer}}{NO_x}\right)_{\text{emissions inventory}}} = (NO_x)\ \text{predicted} \qquad \text{I}$$

For highest accuracy, background concentrations of tracer and NO_x must be subtracted from the measured concentrations, since they are not included in the emissions inventory.

In the present study, we attempt to avoid the use of emissions inventory data by using instead measured tracer/NO_x ratios from the source area (western basin) and comparing them with measured ratios at the receptor sites. Such an analysis will be presented with each case study later in the report. At this point the average mass balance for the 11 day base period will be discussed briefly, using both ground and aircraft data.

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* $HONO_2$ is included in the measured NO_x.

The wind direction during the 11 pertinent sampling days averaged westerly to southwesterly so data from the most western site (Temple City) can be used to determine the source ratios. The tracer/NO_x source ratios from Temple City are found to be 29.6, 0.36, and 0.0074 for CO/NO_x, C_2H_2/NO_x and F-11/NO_x, respectively. In determining these ratios, the small amounts of PAN and particulate nitrate observed at Temple City were combined with the NO_x denominator to better approximate the original source ratios prior to chemical reaction. Using these source ratios and Equation I, the NO_x concentrations predicted by each tracer, as well as the average of the three predicted values, are shown for Upland and Rubidoux in Table 16. Shown for comparison are the sums of the measured nitrogen compound concentrations ($NO + NO_2 + PAN + HONO_2 + NO_3^-$).

TABLE 16. AVERAGE NITROGEN MASS BALANCES FOR 11 DAY PERIOD, 0900-1700 PST

	Predicted NO_x Based on Tracer			Prediction Average	Sum of Measured N-Compounds*
	CO	C_2H_2	F-11		
Upland	0.061	0.053	0.059	0.058 ±0.004	0.050
Rubidoux	0.045	0.042	0.084	0.057 ±0.023	0.052

* $NO + NO_2 + PAN + HONO_2 + NO_3^-$

The agreement between the predicted NO_x concentration averaged over the three tracers and the measured sum of oxidized nitrogen compounds is good for both sites, with about 90 percent of the nitrogen accounted for. The individual tracer predictions for Upland are all similar, giving us confidence in the tracer average prediction. However, the Rubidoux predictions are scattered so that the good agreement between measurements and prediction average is possibly fortuitous.

Undoubtedly some of the missing NO_x can be attributed to physical scavenging, particularly dry deposition. Overall, the mass balances derived from these three tracers are in agreement with the sulfur/nitrogen comparisons in demonstrating that nearly all of the oxidized nitrogen is accounted for.

CASE STUDY 1: NOVEMBER 10, 1976

November 10, 1976, was a cool, sunny, very hazy day in the southcoast basin. Aircraft monitoring results show that high concentrations of O_3 pervaded the entire basin. The ground level data for the day were summarized in Tables 5 through 8; the detailed data are included in Appendix A.

Ozone Transport

Plots of hourly O_3 from Temple City, Upland and Rubidoux are shown in Figure 17. Ozone reached higher concentrations and the peaks occurred slightly later for the more easterly sites. The lower O_3 concentration in Temple City probably results from NO inhibition caused by the strong NO emissions from dense traffic in the area. No significant conclusions can be drawn from the times of O_3 maximum from these curves.

Three aircraft monitoring flights were undertaken in the central and eastern portions of the basin on November 10. The ozone concentrations along the flight paths are mapped for Flights 31-33 in Appendix B. The aircraft monitoring results show elevated O_3 concentrations in the southwestern portion of the study region early in the day, with high O_3 extending throughout the region by afternoon. Earlier studies(13) have postulated the movement of ozone from west to east in the basin, moving on the prevailing winds from the high precursor emissions area in the west to the less populous eastern region. However, a re-evaluation(14) of the ozone data base after correction for calibration differences has minimized the importance of the transport mechanism in causing high O_3 in the eastern basin. In an effort to determine whether a "wave" of ozone is transported from west to east across the basin, one can characterize the time of O_3 maximum at a number of ground stations and infer a progression if a west-east trend is observed. However, the time of O_3 maximum at any given

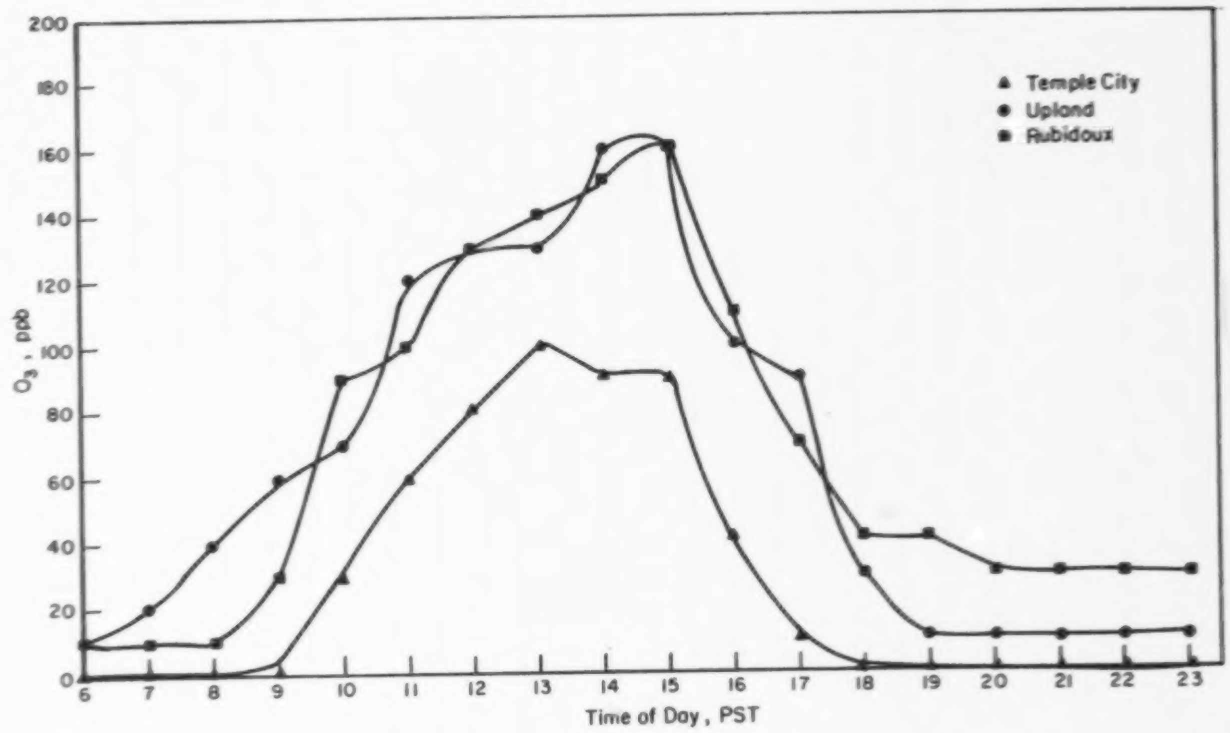

Figure 17. Ozone at three ground stations for November 10, 1976.

ground station may be affected by a number of factors, including local emissions. Another way of inferring transport is to observe movement in the O_3 maximum in a time series of spatial cross-sections of the basin. This technique is especially useful with aircraft data, where the cross-section measurements are made over a very short time and where the O_3 observations, at 1000' AGL, are at least partially uncoupled from local surface emissions. Three such west-east cross-sections for November 10 are pictured in Figure 18. These data were taken from the continuous Pasadena-San Bernardino leg of Flights 31-33, respectively. The O_3 concentration along the west to east path at 08:00 PST was variable but generally low. By noon the concentrations were nearly uniform at 120 ppb along the entire flight path. At 16:00 PST a bit more structure is evident in the O_3 profile. In general, these three profiles provide little evidence for movement of a pulse of ozone across the basin on November 10. Subsequent case studies will investigate this phenomenon further.

The vertical temperature and O_3 profiles in the basin for November 10 are included in Appendix B. All six profiles show layering in the lowest few thousand feet of the atmosphere, with the western-most profile at 12:03 PST exhibiting this effect most dramatically. The profile at 08:26 PST, taken at the southeastern corner of the flight pattern, shows a layer of O_3 reaching 100 ppb at 2800 feet MSL (~2400 feet AGL). It is unlikely that so much O_3 would be generated in the first 2 hours of daylight. It seems likely that much of this O_3 survived from the previous day, trapped between the two thermal inversions evident in the temperature profile at 08:26 PST. Cases of overnight storage of O_3 aloft have been documented in the past(15).

Nitrogen Oxide Reactions

The concentrations of a number of important variables are listed in Table 17 for the three ground stations. Tabulated NO_x values have been corrected for PAN interference. The concentrations of most of the primary pollutants (NO_x, CO, C_2H_2, F-11) were relatively high during the 09:00-11:00

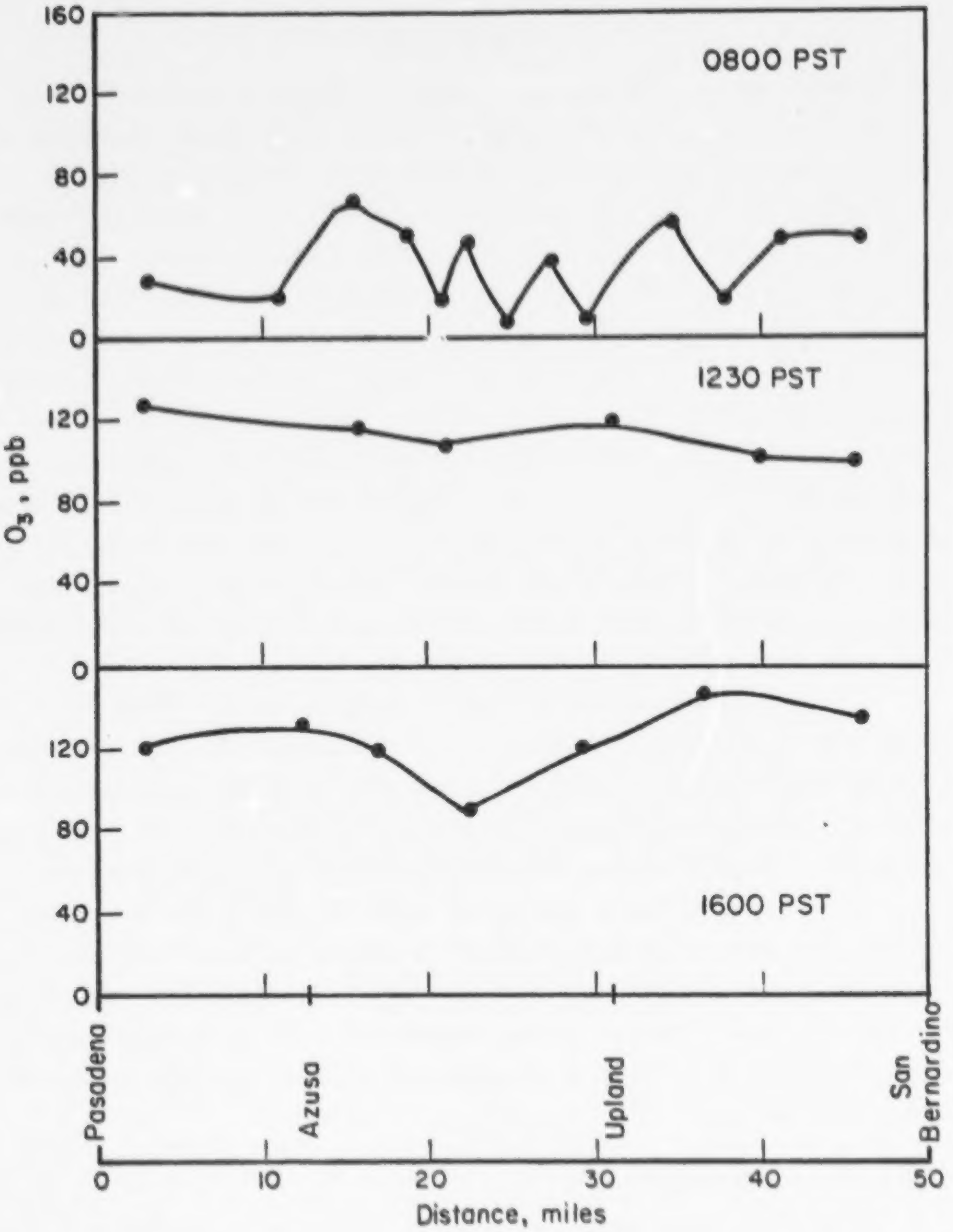

Figure 18. West-east traverses on November 10, 1976.

TABLE 17. PERTINENT AIR QUALITY DATA FROM GROUND STATIONS FOR NOVEMBER 10, 1976 (NO_x Corrected for PAN)

	Averaging Hours, PST				
	9-11	11-13	13-15	15-17	8-Hour Avg.
			Temple City		
NO_x, ppm	.215	.112	.111	.097	.134
CO, ppm	5.00	3.40	3.75	3.70	3.96
C_2H_2, ppmC	.070	.050	.055	.055	.058
F-11, ppt	1159	828	1015	713	929
PAN, ppm	$\leq$.001	.008	.024	.023	.014
NO_3^-, ppm	NA	NA	NA	NA	.00064
SO_2, ppm	.025	.025	.025	.030	.027
$SO_4^=$, ppm	NA	NA	NA	NA	.0046
			Upland		
NO_x, ppm	.071	.044	.054	.065	.059
CO, ppm	2.16	1.53	2.02	2.45	2.04
C_2H_2, ppmC	.035	.023	.042	.035	.034
F-11, ppt	547	396	562	670	544
PAN, ppm	.012	.013	.019	.030	.019
NO_3^-, ppm	NA	NA	NA	NA	.00089
SO_2, ppm	.015	$\leq$.010	$\leq$.010	.030	.015
$SO_4^=$, ppm	NA	NA	NA	NA	.0045
			Rubidoux		
NO_x, ppm	.096	.017	.002	.018	.033
CO, ppm	1.38	1.04	.80	1.46	1.17
C_2H_2, ppmC	.021	.012	.014	.019	.017
F-11, ppt	364	479	364	893	525
PAN, ppm	.004	.008	.008	.017	.009
NO_3^-, ppm	NA	NA	NA	NA	.0053
SO_2, ppm	.015	.025	.030	.040	.028
$SO_4^=$, ppm	NA	NA	NA	NA	.0034

PST period, with the exception of SO_2, which was relatively constant during the day at Temple City and Upland, but continually increased at Rubidoux. The PAN concentration increased substantially with time at all three sites.

Table 18 lists ratios of a number of atmospheric constituents at the ground sites. Ratios will be useful in this analysis in accounting for air mass dilution. The concentrations of relatively inert species like CO and C_2H_2 can serve as dilution tracers for air parcels containing reactive species such as NO_x. If we assume that the predominant source of the reactive and inert species is the same, i.e., vehicular emissions account for most of the measured CO, C_2H_2 and NO_x, then the ratio should remain constant during dilution except for the amount of the reactive component removed by chemical or physical processes. Under these conditions, changes in ratio can be used to determine removal of the reactive component. In the simplest case, consider a polluted air parcel which is uncoupled from surface emissions and which is being monitored with time as it moves (Lagrangian framework). In this case the ratio of an inert gas to a reactive gas (e.g., CO/NO_x) can be used directly to calculate the fraction of the reactive gas (NO_x) removed from the air and the rate of removal*.

In the second case, allow fresh surface emissions to mix into the air parcel. If the ratio of the fresh emissions is similar to the starting ratio (e.g., vehicular emissions), then measured changes in the ratio with time can be used to set a lower limit on removal rate. The greater the fraction of fresh emissions added, the lower the apparent removal rate. If fresh emissions are minimal, the apparent rate will approximate the true rate. If the CO/NO_x ratio of the fresh emissions is different than the ratio originally present in the air parcel, then the assumptions are not met and the calculation becomes invalid.

In the final case, consider measurements at one or more fixed locations. The caveats regarding fresh emissions still apply, and in addition, knowledge of the reaction time is much less certain. In order to make sense of this type of data one must assume:

(1) The upwind source region CO/NO_x emission ratio is constant during the day.

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* As the air parcel is diluted, it becomes necessary to correct for the tracer and NO_x concentrations in the dilution air.

TABLE 18. GROUND LEVEL RATIOS FOR NOVEMBER 10, 1976.

	9-11	11-13	13-15	15-17
		Temple City		
CO/NO_x	23.2	30.4	33.8	38.1
C_2H_2/NO_x	.32	.45	.50	.57
CO/C_2H_2	71.4	68.0	68.2	67.3
$F\text{-}11/NO_x$*	5,390	7,392	9,144	7,350
$PAN/(NO_x + PAN)$	0	.07	.18	.19
NO_x/SO_2	8.6	4.5	4.4	3.2
		Upland		
CO/NO_x	30.4	34.8	37.4	37.7
C_2H_2/NO_x	.49	.52	.78	.54
CO/C_2H_2	61.7	66.5	48.1	70.0
$F\text{-}11/NO_x$*	7,704	9,000	10,470	10,380
$PAN/(NO_x + PAN)$	.14	.23	.26	.32
NO_x/SO_2	4.7	4.4	5.4	2.2
		Rubidoux		
CO/NO_x	14.4	61.1	400	81.1
C_2H_2/NO_x	.22	.71	7.0	1.1
CO/C_2H_2	65.7	86.7	57.1	76.8
$F\text{-}11/NO_x$*	3,791	28,176	182,000	49,611
$PAN/(NO_x + PAN)$	.04	.32	.82	.49
NO_x/SO_2	6.4	.68	.07	.45

* ppt/ppm

(2) The CO/NO_x ratio of any fresh emissions mixing into the air is similar to the starting ratio. (Assumptions 1 and 2 are reasonable if the source of CO and NO_x is the same).

(3) The concentrations of pollutants resulting from local emissions are small compared to the concentrations resulting from the original pollutant charge.

When these assumptions are valid then the change in ratio with time at a fixed ground site can be used to approximate NO_x removal rates. In the southcoast basin, the ideal situation represented by these assumptions will not always prevail. Consequently we will have to be content with only a rough estimate of NO_x reaction rate.

Nitrogen Compound Distribution on November 10, 1976--

Averaged over the 8-hour daylight sampling period, approximately 9 percent of the oxidized nitrogen at Temple City was present in the form of NO_x reaction products, 25 percent at Upland, and about 40 percent at Rubidoux. The PAN concentration reached a maximum at Upland, whereas particulate nitrate peaked at Rubidoux. The ratio of the NO_x reaction products $\frac{\text{PAN}}{\text{particulate nitrate}}$ averaged about 22 at Temple City and Upland, but dropped to 1.7 at Rubidoux. High particulate nitrate concentrations have frequently been observed in the eastern portion of the basin. The higher levels of aerosol nitrate in the eastern basin most likely result from the additional reaction time provided by the longer trajectories from the main emission areas to the west, combined with the high concentrations of NH_3 observed just to the west of Rubidoux, which would contribute to the formation of NH_4NO_3. The high levels of NH_3 observed by Tuazon, et al.,(17) are thought to be due to animal feedlots between Chino and Rubidoux.

The distribution of sulfur species is rather different from nitrogen. The SO_2 concentrations were generally similar at all three sites and showed gradual increases during the day. This is in direct contrast to NO_x behavior. Sulfate concentrations were also similar at all three sites, suggesting a uniformity across the basin, again in sharp contrast to particulate nitrate.

Historically, one of the reasons for interest in atmospheric NO_x chemistry was the fact that SO_4/NO_3 ratios in Los Angeles never agreed with SO_2/NO_x emissions inventory ratios. Emissions data from 1971-1974 indicate that the SO_2/NO_x molar emissions ratio averages 0.2. However, the ratio of particulate $SO_4^=$ to NO_3^-, the species considered to be the predominant reaction products, averaged about 2.0*. In fact, when inert filter materials are employed for sampling, the particulate nitrate concentrations are even lower and the discrepancy becomes worse. For example, the $SO_4^=/NO_3^-$ molar ratio for the three ground sites on November 10 are shown in the table below.

TABLE 19. MEASURED MOLAR RATIOS FOR NOVEMBER 10, 1976

	Temple City	Upland	Rubidoux
$SO_4^=/NO_3^-$	7.1	5.1	0.6
$\frac{SO_2 + SO_4^=}{NO_x + PAN + NO_3^-}$	0.21	0.25	0.65

The east-west nitrate gradient is apparent in these $SO_4^=/NO_3^-$ ratios, but even more important to this discussion is the fact that all of the $SO_4^=/NO_3^-$ ratios are much higher than the 0.2 SO_2/NO_x emissions ratio. From our earlier studies, where PAN and $HONO_2$ were found to be the major initial NO_x reaction products, the cause of the discrepancy became obvious; while sulfate is virtually the only product of SO_2 reactions, aerosol nitrate is initially only a minor product of the NO_x reactions. The second set of ratios in Table 19 provides a more realistic appraisal of the sulfur and nitrogen ratios, in that all the important species are included (nitric acid is not listed specifically because its concentration was less than the instrumental detection limit and because the NO_x measurement includes gaseous $HONO_2$). The ratios at Temple City and Upland are very close to the emissions ratios, which is evidence that the major species are all accounted for. The Rubidoux ratio is nearly three times higher, due principally to lower NO_x concentrations. Since emissions data from the eastern basin were not included in the inventories quoted above, quantitative comparisons for Rubidoux are probably not valid.

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* Values in 1966 and 1967 for five L.A. sites ranged from 1.8 to 2.3.

The aircraft sampling flights on November 10 consisted of a series of four north-south traverses almost equally spaced from Temple City to Riverside. The flight pattern, which is shown in Appendix B, was carried out three different times during the day. The flight data were reported in Table 9. Selected portions of the data along with pertinent ratios are presented in Table 20. Note that the NO_x concentrations have been corrected for PAN interference in Table 20. At the time of this study, no technique for airborne monitoring of nitric acid was available, and aerosol samples were not obtained aboard the plane. Consequently the only aircraft information pertinent to nitrogen oxides distribution is the NO_x and PAN data. The bottom line of the table shows the ratio of PAN to total measured oxidized nitrogen compounds. Interestingly, the highest ratio of $PAN/(NO_x + PAN)$ when averaged over all four traverses, occurred for the early morning flight. However, a comparison of ground station and aircraft results as well as the vertical profiles from this flight (Appendix B) suggest that, for much of the early morning the plane may have been sampling above the morning inversion. If the plane were sampling the previous day's air trapped aloft between inversion layers, it would explain the high concentrations of PAN and the high $\frac{PAN}{NO_x + PAN}$ ratio.

The ratios from the ground stations can be compared with those aloft by averaging the ratios over the three flights for each north-south traverse. This provides an average daylight $\frac{PAN}{NO_x + PAN}$ ratio for four geographical locations (at 1000' AGL) which can be compared with the 8-hour average ratios for the ground stations. Such a comparison is made in Figure 19, where the west to east spacing of the sample locations serves as the abscissa. It is uncertain what type of curve should be fitted to these points, but an increasing west to east trend is apparent in the data. With southwesterly and westerly winds, the eastern locations experience air which has had more time to react. The increased reaction time accounts for the greater conversion to PAN.

Loss of Nitrogen Oxides--

The rate of NO_x removal can be estimated from the ground station data using conserved gases such as CO and C_2H_2 to account for dilution,

TABLE 20. AIRCRAFT RESULTS FOR NOVEMBER 10, 1976

Flight No.	31				32				33			
Time	08:00 PST				12:30 PST				10:00 PST			
Traverse*	1	2	3	4	1	2	3	4	1	2	3	4
CO, ppm	1.25	1.40	.86	.85	2.57	.165	1.20	.95	1.80	2.15	1.80	1.30
NO_x**, ppm	.066	.046	.035	.030	.133	.131	.060	.060	.085	.157	.100	.074
C_2H_2m ppmC	.012	.017	.012	.011	.033	.021	.013	.008	.026	.030	.025	.019
C_2H_4, ppmC	.015	.015	.015	.020	.040	.030	.026	.015	.038	.041	.038	.035
F-11, ppt	324	367	281	382	680	497	-1	382	695	662	893	464
PAN, ppm	.004	.010	.006	.005	.017	.010	.012	.010	.018	.013	.013	.011
CO/C_2H_2	104	82	72	77	78	79	92	119	69	72	72	68
C_2H_4/C_2H_2	1.2	0.9	1.2	1.8	1.2	1.4	2.0	1.9	1.5	1.4	1.5	1.8
CO/NO_x	18.9	30.4	24.6	28.3	19.3	12.6	20.0	15.8	21.1	13.7	18.0	24.5
C_2H_2/NO_x	.18	.37	.34	.37	.25	.16	.22	.13	.30	.19	.25	.26
$F\text{-}11/NO_x$	4909	7978	8028	12,733	5112	3793	-	6367	8176	4216	8930	6270
$PAN/(NO_x + PAN)$	.06	.18	.15	.14	.11	.07	.17	.14	.17	.08	.12	.13

*In order from west to east

**Corrected for PAN

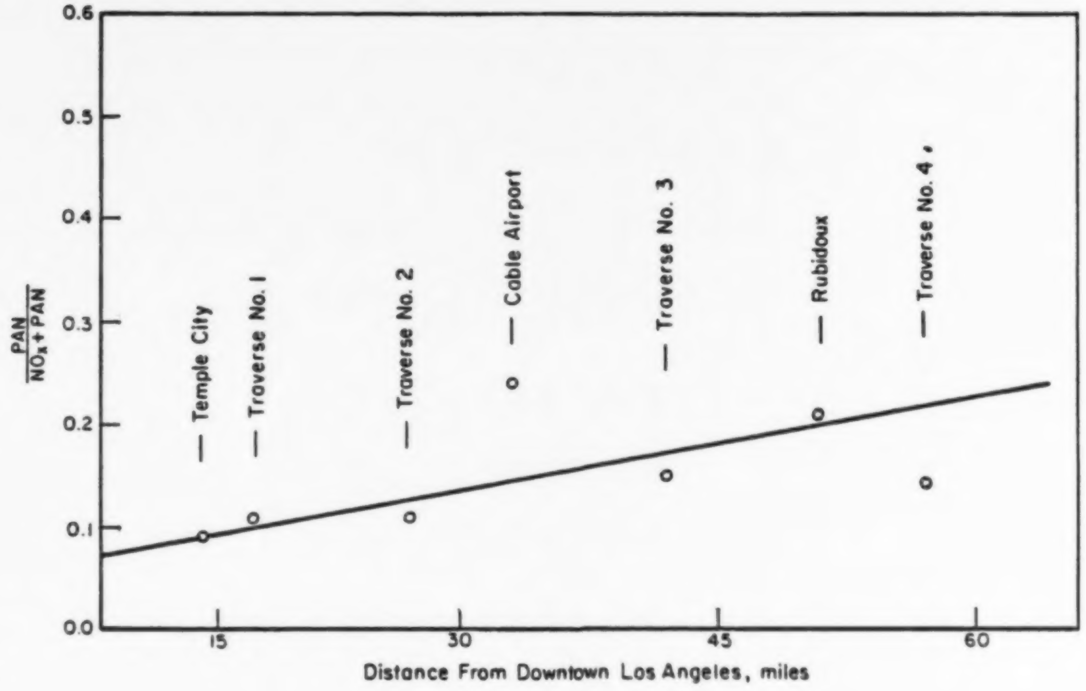


Figure 19. $\frac{PAN}{NO_x + PAN}$ ratios aloft and on the ground for November 10, 1976.

if the assumptions discussed earlier are valid. The poorest assumption for an area such as the southcoast basin is that no fresh emissions are added to the air parcel as it moves from the source (downtown and industrial sections of Los Angeles) to the receptor sites. Since this assumption is certainly not valid, the estimates of NO_x loss rates must be considered lower limits only.

Examination of the CO/NO_x and C_2H_2/NO_x ratios at Temple City, shown in Figure 20, suggests a lower limit loss rate of 6-8 percent per hour. It is difficult to assign a more exact value due not only to the aforementioned problem of fresh emissions but also to the question of reaction time. It has been assumed that air monitored at the midpoint of each 2-hour sampling interval has experienced an additional 2 hours of irradiation since the previous sampling period. This is likely to be true for the Upland and Rubidoux sites, which are far removed from the main source of emissions. For Temple City however, the pollutants arriving later in the day may have been emitted in Los Angeles only 2 or 3 hours earlier. This is clear in the trajectory for Temple City, shown in Figure 21. To the extent that this overestimation of reaction time occurs, it also leads to an underestimation of reaction rate.

Also included in Figure 20 is a plot of $PAN/(NO_x + PAN)$. Assuming that PAN is the major initial reaction product of NO_x and that only minimal nitrogen is lost by deposition along the trajectory to Temple City, then the $(NO_x + PAN)$ denominator will serve as a conserved tracer of dilution. Figure 20 shows that the fraction of total nitrogen oxides accounted for by PAN increased from 0 to nearly 20 percent from 10:00 to 16:00 PST. This implies that NO_x is converted to PAN at a minimum of 3-4 percent per hour. This rate is again a lower limit, subject to all the caveats regarding fresh emissions and reaction time discussed earlier.

A similar set of plots is presented in Figure 22 for Upland on November 10, 1976. Ignoring one questionable acetylene point, the average NO_x removal rate at Upland appears to be 1-3 percent per hour, about the same as the estimated rate of NO_x conversion to PAN. Once again, these estimates are lower limits. It is interesting to note that a high concentration of PAN was observed at the start of the sampling period at Upland, and that the $PAN/(NO_x + PAN)$ ratio was 0.14 for the 09:00-11:00 PST period. This is

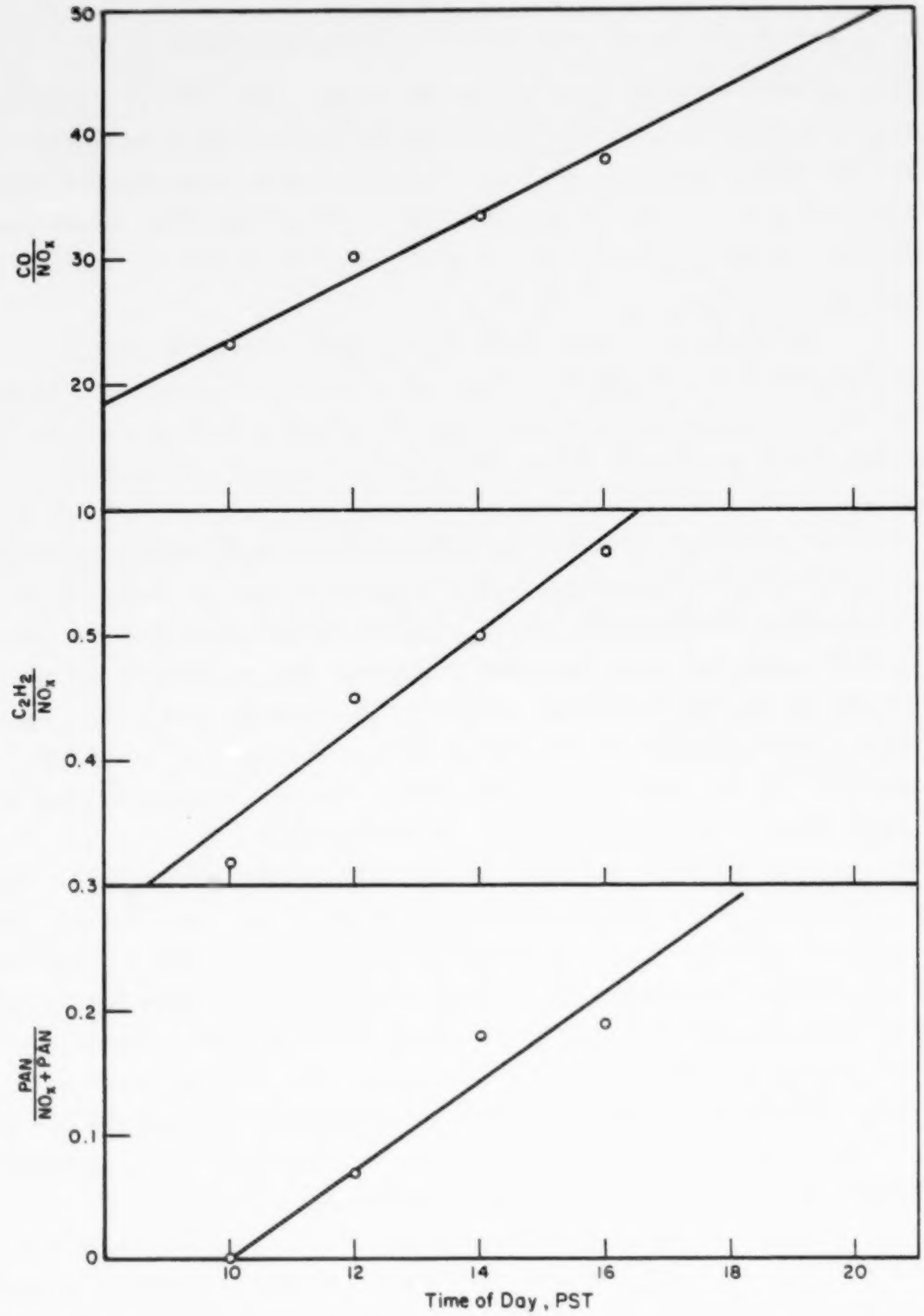


Figure 20. Temple City ratios vs time for November 10, 1976.

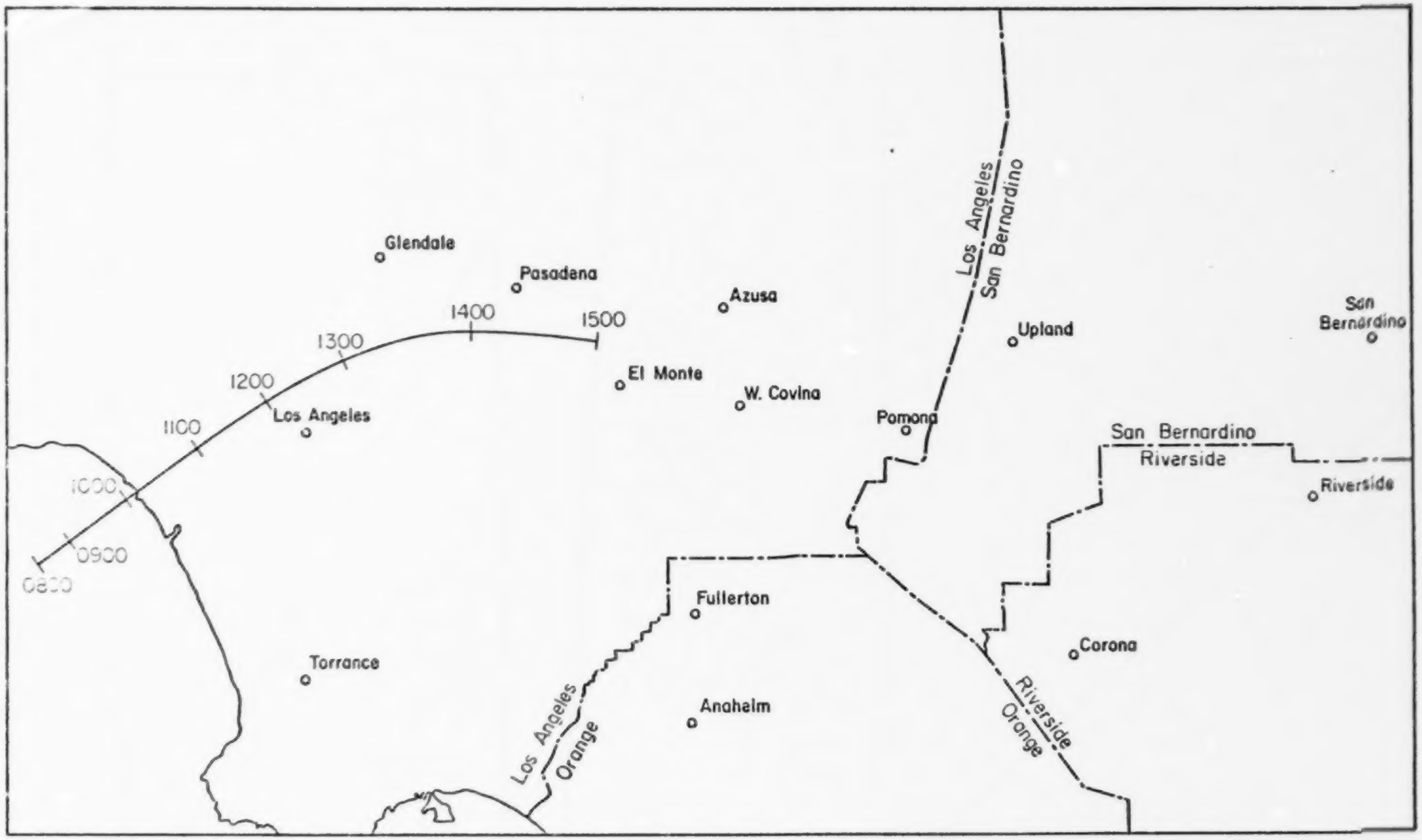

Glendale
Pasadena
Azusa
Upland
San Bernardino
El Monte
W. Covina
Los Angeles
Pomona
Los Angeles
San Bernardino
San Bernardino
Riverside
Riverside
Fullerton
Corona
Torrance
Anaheim
Los Angeles
Orange
Riverside
Orange
0800
0900
1000
1100
1200
1300
1400
1500

Figure 21. Trajectory ending at Temple City at 15:00 PST on November 10, 1975.

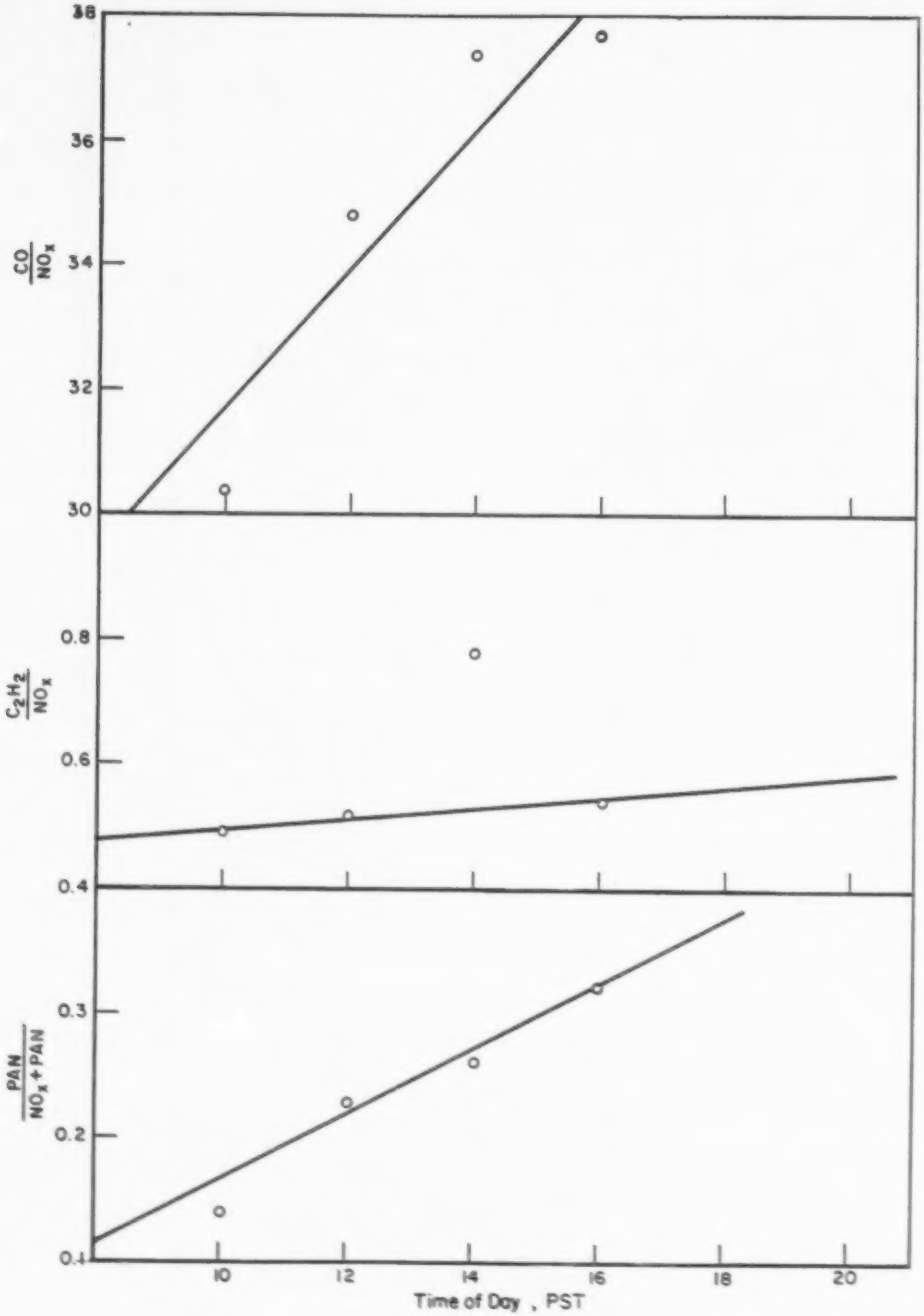


Figure 22. Upland ratios vs time for November 10, 1976.

surprisingly high for so early in the morning and may indicate that the site was being influenced by products from the previous day's reaction. We discussed earlier the possibility that O_3 had been stored aloft between inversion layers overnight. Storage of pollutants aloft, with subsequent fumigation after the inversion breakup, may have been responsible for the high morning PAN concentrations.

Plots of the November 10, 1976 Rubidoux ratios are shown in Figure 23. The slopes of the CO/NO_x and C_2H_2/NO_x lines suggest NO_x loss rates of 15-16 percent per hour. This estimate is again a lower limit, but should probably represent the true rate better than the results from the other two stations due to the distance between this station and the major emissions area. Figure 24 shows the calculated trajectories for air parcels arriving at Rubidoux at 15:00 and 17:00 PST. Air arriving at Rubidoux in the afternoon resided north to northwest of Anaheim early in the morning during rush hour, and probably accumulated most of its pollutant burden at that time. The subsequent trajectories carried these air parcels over some of the least densely populated portions of the basin. It is because of this long fetch with minimal fresh emissions to the air parcels that the NO_x conversion rates for Rubidoux may be most accurate.

Under the conditions just described, even a gas from a source different from NO_x may serve as a dilution tracer. A plot of the $F\text{-}11/NO_x$ ratio is included as Figure 25. The slope of the line predicts an average NO_x removal rate constant of 16 percent hr^{-1}, in agreement with the CO and C_2H_2 results.

The percentage of oxidized nitrogen existing as PAN increased from 4 percent to nearly 50 percent during the day at Rubidoux. This ratio is shown graphically in Figure 23. The increase in this ratio suggests that NO_x is transformed to PAN with a .08 hr^{-1} rate constant. This is about half of the NO_x removal rate, the same fraction found at Temple City. Particulate nitrate, which makes up a considerable fraction of the oxidized nitrogen at Rubidoux, can account for part of the remaining loss, while low concentrations of nitric acid and some loss due to dry deposition most likely account for the remainder.

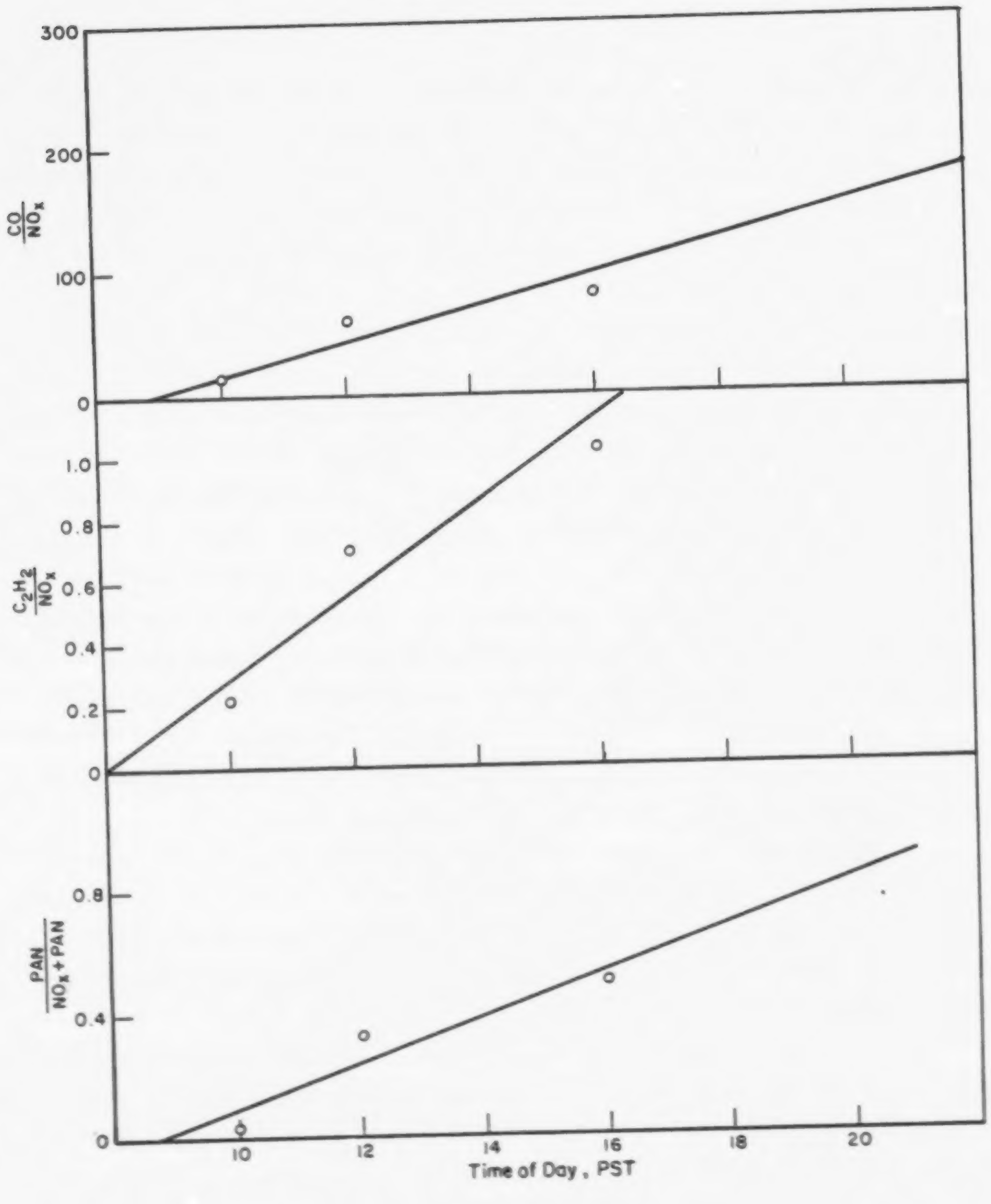


Figure 23. Rubidoux ratios vs time for November 10, 1976.

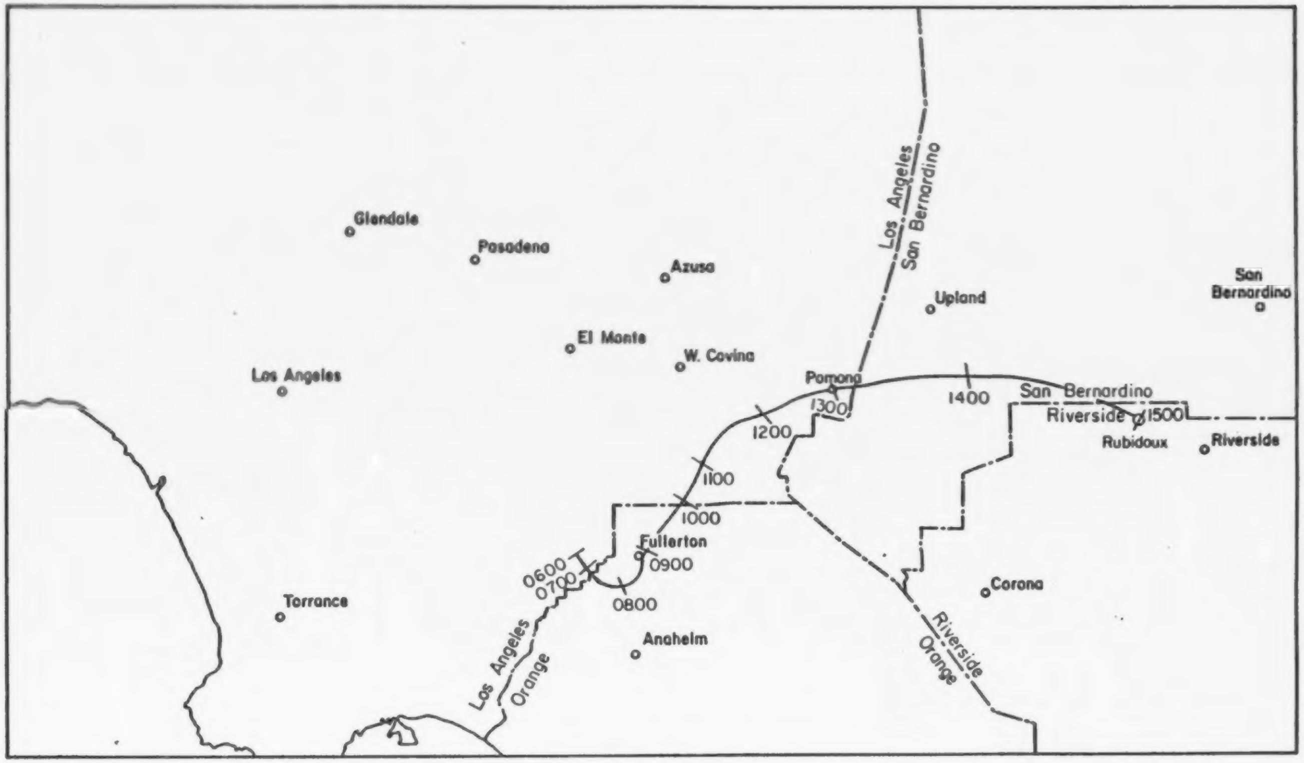

Glendale
Pasadena
Azusa
Los Angeles
San Bernardino
Upland
San Bernardino
El Monte
W. Covina
Los Angeles
Pomona
1400
San Bernardino
Riverside
1500
1300
1200
Rubidoux
Riverside
1100
1000
Fullerton
0900
0600
0700
0800
Corona
Torrance
Anaheim
Los Angeles
Orange
Riverside
Orange

Figure 24A. Trajectory ending in Rubidoux at 1500 PST, 10 November, 1976.

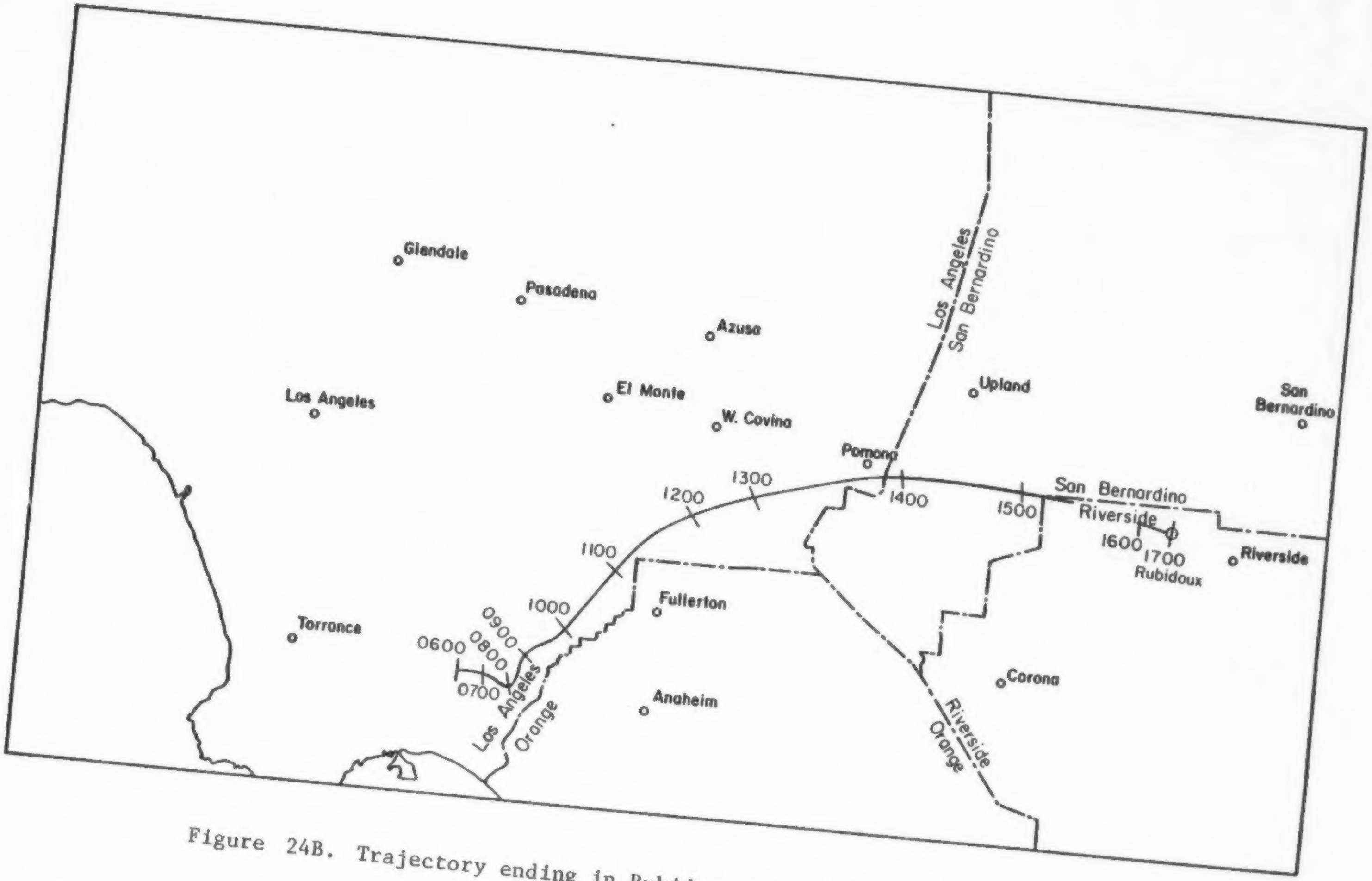

Glendale
Pasadena
Azusa
Los Angeles
San Bernardino
Upland
San Bernardino
Los Angeles
El Monte
W. Covina
Pomona
1300
1200
1400
1500
San Bernardino
Riverside
1600
1700
Rubidoux
Riverside
1100
1000
Fullerton
Torrance
0900
0800
0600
0700
Los Angeles
Orange
Anaheim
Corona
Riverside
Orange

Figure 24B. Trajectory ending in Rubidoux at 1700 PST, 10 November, 1976.

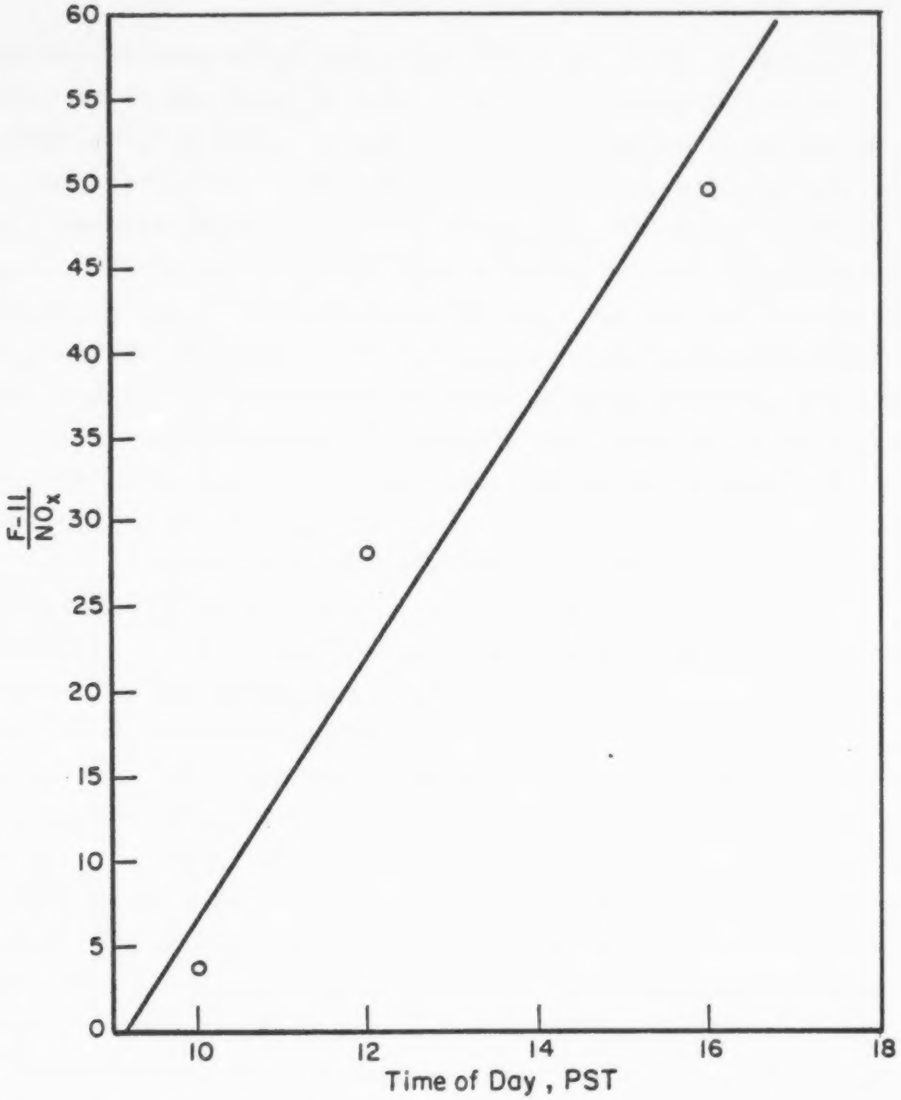


Figure 25. Rubidoux ratios vs time for November 10, 1976.

CASE STUDY 2: NOVEMBER 5, 1976

November 5, 1976, was a very hot sunny day in southern California. Hot dry desert winds, known locally as Santana or Santa Ana winds, resulted in an offshore flow from the north and northeast. The relatively good mixing in the basin prevented the buildup of primary pollutants, and ozone concentration remained $\leq$ 80 ppb at all three ground stations. The concentration of PAN never exceeded 2.0 ppb at any of the ground stations. While the low O_3, PAN and precursor concentrations render the ground station results rather uninteresting, the seaward flow of air provides a unique opportunity for airborne study of chemical transformations, without the injection of fresh emissions that complicates studies within the basin.

The flight patterns and spiral data for Flights 23-25 are included in Appendix B. The two offshore spirals from Flight 23 show a low lying morning inversion within the first 600-800 feet above the sea. The first vertical profile, at 09:20, shown in Figure 26 evidences an erosion of the ambient ozone concentration within the inversion, due most likely to reaction of the O_3 with NO and other primary pollutants emitted by basin sources. The opposite of this effect was observed later in the day at 14:05 PST further offshore from the emission sources. The 14:05 PST spiral from Flight 24, shown in Figure 26C, exhibits a very strong buildup of O_3 within the inversion layer. A similar effect was observed during Flight 8 on October 26. The reason for the O_3 deficit in one case (09:20 PST) and O_3 excess in the other (14:05 PST) relates to reaction time and proximity to the emissions sources. The first profile was obtained very near the coast close to strong emissions sources, and the primary emissions trapped within the inversion are expected to scavenge O_3. The later profile (14:05 PST) was taken far from primary emissions sources and after the trapped pollutants had reacted for 4-5 hours. In this case the high concentrations of O_3 precursors trapped in the inversion layer have produced ozone approaching 300 ppb near the surface.

It is clear from the O_3 results of Flights 23-25 that the offshore flow resulted in very high levels of ozone moving southward along the coast toward the Mexican border. Photochemical reactions responsible for

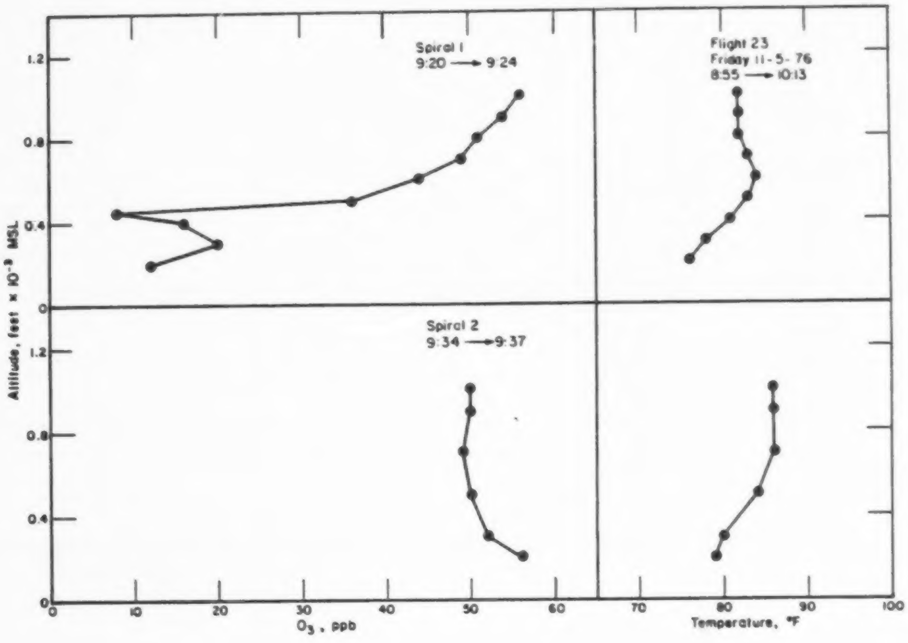


Figure 26A. Vertical profiles from Flight 23, November 5, 1976.

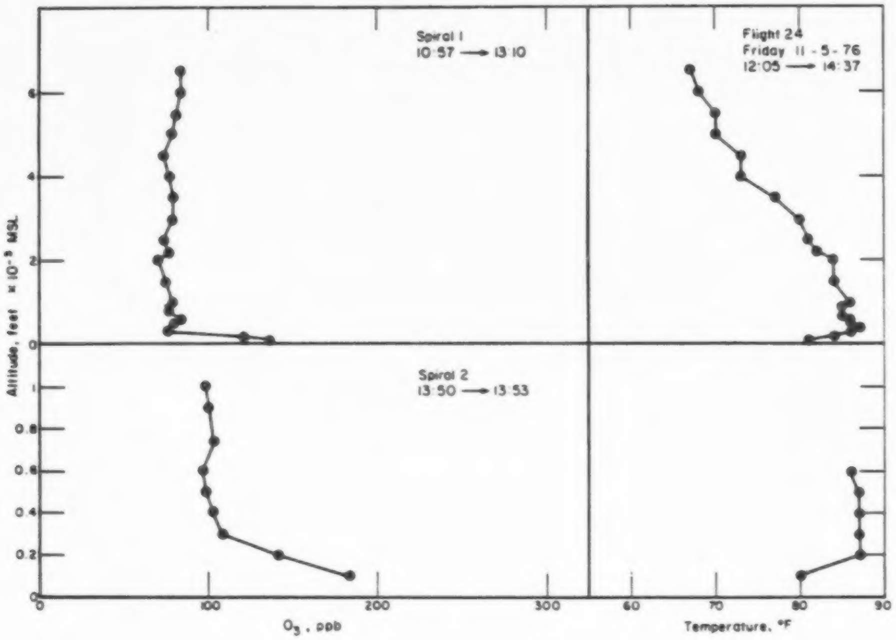


Figure 26B. Vertical profiles from Flight 24, November 5, 1976.

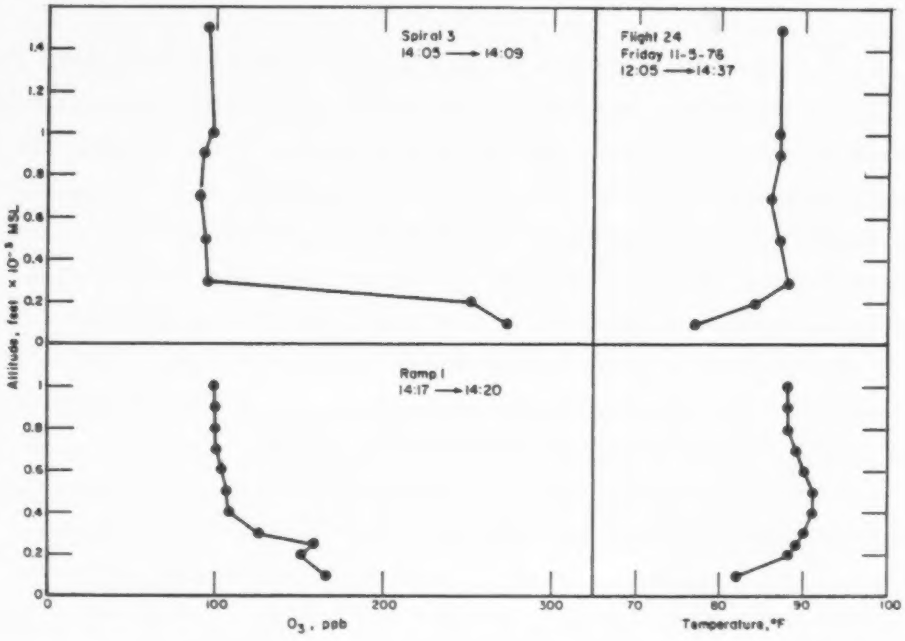


Figure 26C. Vertical profiles from Flight 24, November 5, 1976.

ozone formation also result in NO_x transformations, so it should be possible to determine NO_x removal based on the successive downwind flights. Trajectory analysis can be used to determine reaction time, and ultimately transformation rates.

Pertinent data from bag samples collected during Flights 23-25 are shown in Table 21. Because of the strong inversion, these samples were collected within 100 feet of the ocean's surface. It is evident that high pollutant concentrations are trapped within the inversion. Sample 23-1 was taken offshore from Santa Ana at 09:10 PST, before significant transformation had occurred, as judged by the low O_3 (Figure 26A) and PAN concentrations. The high precursor concentrations, the time, and the location of this sample make it well suited as a reference against which the later flights can be judged. CO and C_2H_2 will be used as dilution tracers to determine the amount of NO_x removed from the downwind air samples.

Pertinent ratios from the reference sample, 23-1, and further downwind samples are shown in Table 22. The CO/C_2H_2 ratios from all the samples fall very close to the average auto exhaust value, as do the reference sample CO/NO_x and C_2H_2/NO_x ratios. This suggests that the reacting pollutants are derived principally from auto exhaust trapped within the low inversion.

TABLE 21. BAG DATA FROM FLIGHTS 23-25 (NO_x Corrected for PAN)

Flight	Bag No.	CO, ppm	C_2H_2, ppmC	NO_x, ppm	PAN ppm
23	1	5.70	.081	.350	.001
23	2	1.08	.012	.100	.001
24	1	0.80	.010	.050	.001
24	2	4.38	.052	.255	.020
24	3	5.70	.091	.294	.031
25	1	2.90	.040	.157	.008
25	2	1.25	.026	.086	.004

TABLE 22. RATIOS FROM FLIGHTS 23-25

Flight	Bag No.	CO/C_2H_2	CO/NO_x	C_2H_2/NO_x	$\frac{PAN}{NO_x+PAN}$
23	1	70	16.3	.23	0
24	1	80	16.0	.20	0
24	2	84	17.2	.20	.08
24	3	63	19.4	.31	.10
25	1	72	18.5	.25	.05
25	2	48	14.5	.30	.04

Using the reference sample ratios and Equation I, the NO_x deficits reported in Table 23 were calculated. In general, the C_2H_2 measurements will be less accurate than CO due to measurement difficulties at the lower C_2H_2 concentrations, so the deficits based on CO should be given more weight. The variations in average NO_x deficit are qualitatively similar to the variations in PAN concentration, except for sample 24-2, where the low value based on C_2H_2 has biased the average. The CO-derived NO_x deficit tracks both the PAN and O_3 (Appendix B) concentrations fairly well for Flight 24. Based on the calculated deficits, about 5 percent of the NO_x from sample 24-2 and 16 percent from 24-3 has been removed by chemical or physical processes. This can be compared with the actual measurements, which show that 8 and 10 percent, respectively, of the oxidized nitrogen is in the form of PAN. No doubt some additional NO_x can be attributed to unmeasured concentrations of $HONO_2$ and particulate nitrate. Although the NO_x deficits are subject to large uncertainties, it is evident that PAN accounts for a major fraction of the reacted NO_x.

The O_3 and NO_x monitoring data from Flight 23 (Appendix B) indicate that highly polluted Los Angeles morning air was located just offshore from Santa Ana (sample 23-1) at 09:30 PST. The area where sample 24-3 was collected later in the day was relatively clean in midmorning. Over the 4.5 hour reaction time between the 09:30 sample and the two 14:00 PST sampels (24-2, 24-3) the average NO_x removal rate was 0.003-0.012 ppm hr^{-1} and the average rate constant was in the range of 1-3 percent hr^{-1}. The average rate of transformation to PAN falls in the range 1-2 percent per

TABLE 23. NO_x (ppm) DEFICITS FOR OCEAN AIR SAMPLES

Sample	Deficit Based On: CO	C_2H_2	Average
24-1	0.000	-0.006	-0.003
24-2	0.014	-0.029	-0.007
24-3	0.056	0.101	0.079
25-1	0.021	0.017	0.019

hour. The low rates are very likely the result of the relatively high NO concentrations initially present in the air parcel. The strong inversion maintained the high NO concentrations so that it probably required 1-2 hours to obtain a NO_2/NO ratio favorable to the formation of PAN. This induction period may be responsible for the low average rates. This subject will be discussed in more detail in a later section.

Data from the furthest downwind sample, 25-1, indicate a 12 percent loss of NO_x after approximately 7.5 hours of reaction. Therefore an average rate of 1-2 percent per hour is indicated. PAN accounted for 5 percent of the measured oxidized nitrogen, and the transformation to PAN averaged less than 1 percent per hour. It is important to emphasize that these are average rates, and that the maximum transformation rates are likely to be much higher.

CASE STUDY 3: OCTOBER 25, 1976

October 25, 1976, was a warm hazy day in southern California. A land breeze had developed overnight but by 09:00 PST an organized westerly flow had set in. The chemical and meteorological ground station results were summarized in Tables 5-8 and are tabulated in detail in Appendix A.

Ozone Transport

Plots of the diurnal ozone patterns for three ground stations are included as Figure 27. Ozone at Temple City peaked at 13:00 PST and

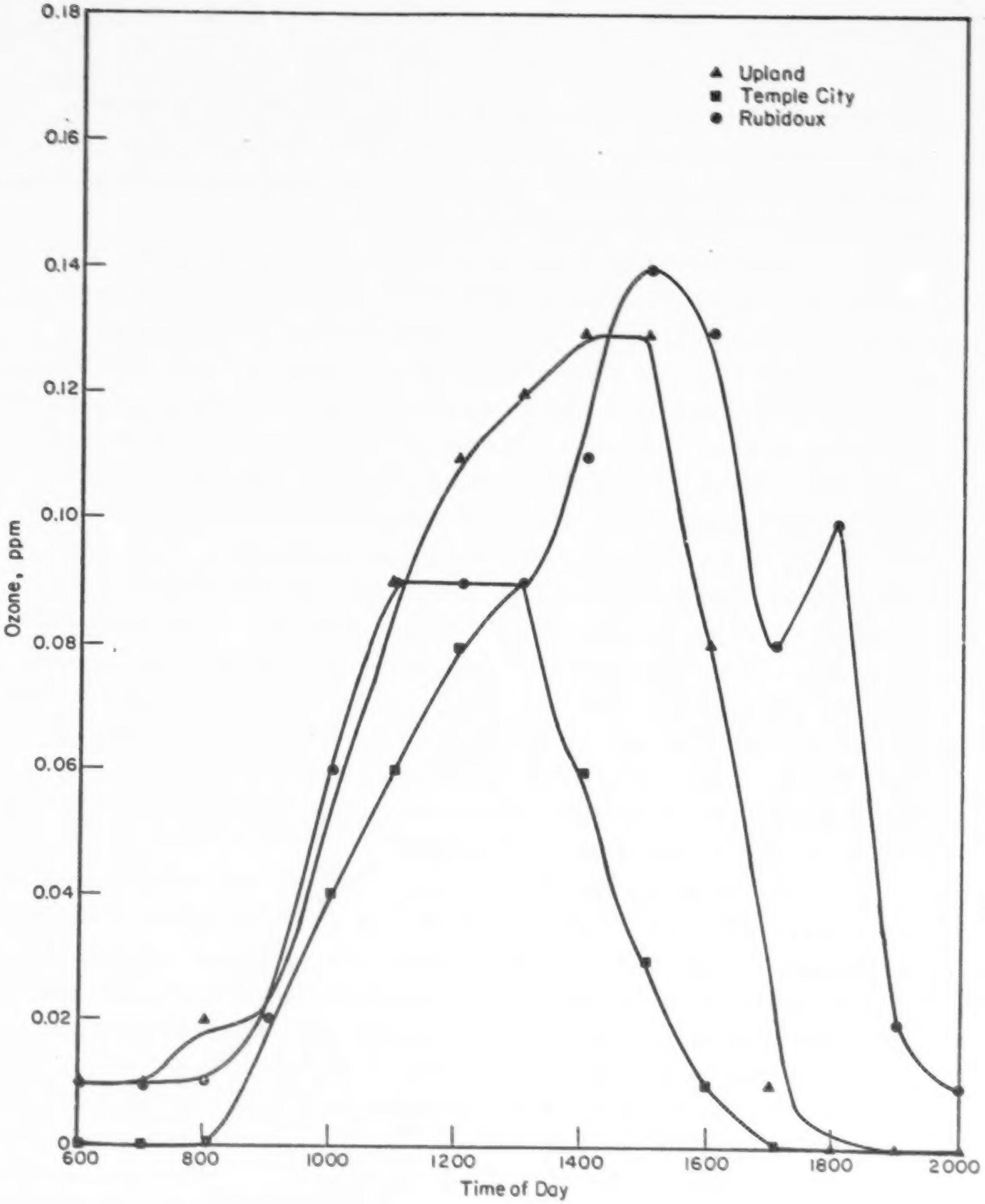


Figure 27. Ozone results from ground stations, October 25, 1976.

decreased rapidly during the remainder of the afternoon. As mentioned earlier, the lower peak concentrations and rapid removal of O_3 at Temple City relate to the proximity of the station to strong sources of O_3 scavengers, principally NO from auto exhaust.

Ozone peaked at Upland at 14:00 PST but dropped rapidly after 15:00. At Rubidoux the ozone concentration reached a plateau between 11:00-13:00 PST, corresponding to O_3 formation from local precursor sources. Even higher O_3 concentrations were observed at 15:00 and again at 18:00 PST. These latter peaks are most likely due to O_3 transport from an upwind source. The flight patterns and vertical profiles from Flights 5 and 6 are shown as Figures 28A and B and 29A and B. The vertical data from Flight 5 show a sharp break in the ozone concentration at 4000 feet MSL at both El Monte and the southeast corner of the pattern. Unfortunately the vertical temperature data from this flight were not recorded due to a recorder malfunction; however the break at 4000 feet is undoubtedly due to an inversion. Ozone concentrations between 175-200 ppb were observed from the surface up to 4000 feet at 13:00 PST. Later in the day very high concentrations of O_3 were found aloft in a layer at 3000 feet MSL, as seen in Figure 29B. Concentrations exceeding 250 ppb were observed at 16:00 PST in both the western and eastern vertical profiles. In both cases the O_3 decreased rapidly near the surface.

Due to the atmospheric layering evident in the vertical profiles, the aircraft altitude varied in an attempt to track the maximum ozone concentrations during Flights 5 and 6. Horizontal profiles of the continuous west to east basin cross sections from Pasadena to San Bernardino from the two flights are graphed in Figure 30. Higher concentrations were found toward the west in the earlier flight and in the eastern basin during the later flight. An air mass trajectory ending in Riverside at 16:00 PST is shown in Figure 31 and demonstrates west to east flow. This is confirmed by both the ground station results and the flight data. With the many recent documented cases of ozone/precursor transport over long distances, such short range transport in the southeast basin is not surprising. However, the formation of pollutant layers aloft, as exhibited by the

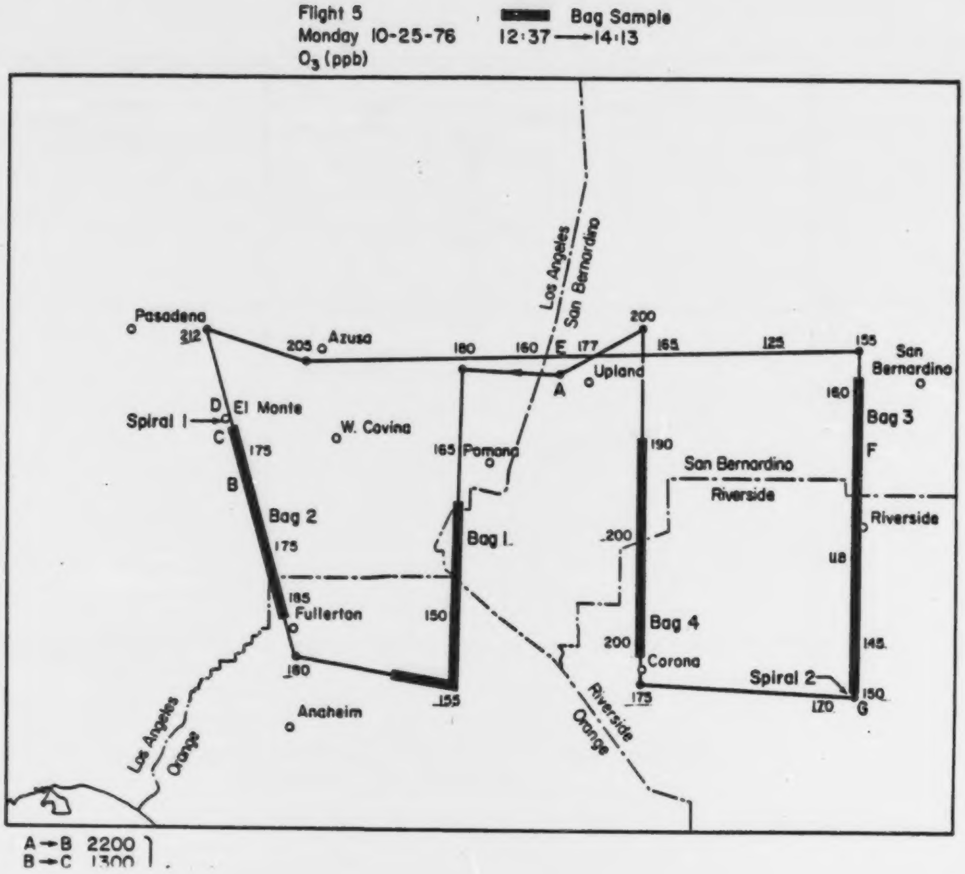

Flight 5
Monday 10-25-76
O3 (ppb)
Bag Sample
12:37 → 14:13
Pasadena
212
205
Azusa
180
160
E
177
200
165
125
155
San Bernardino
Upland
A
Los Angeles
San Bernardino
160
Bag 3
F
D
El Monte
Spiral 1
C
175
W. Covina
165
Pomona
190
San Bernardino
Riverside
B
Bag 2
175
Bag 1.
200
Riverside
118
185
Fullerton
150
Bag 4
200
Corona
145
Spiral 2
180
155
173
170
G
150
Anaheim
Riverside
Orange
Los Angeles
Orange
A → B 2200
B → C 1300

Figure 28A. Flight path for Flight 5, October 25, 1976.

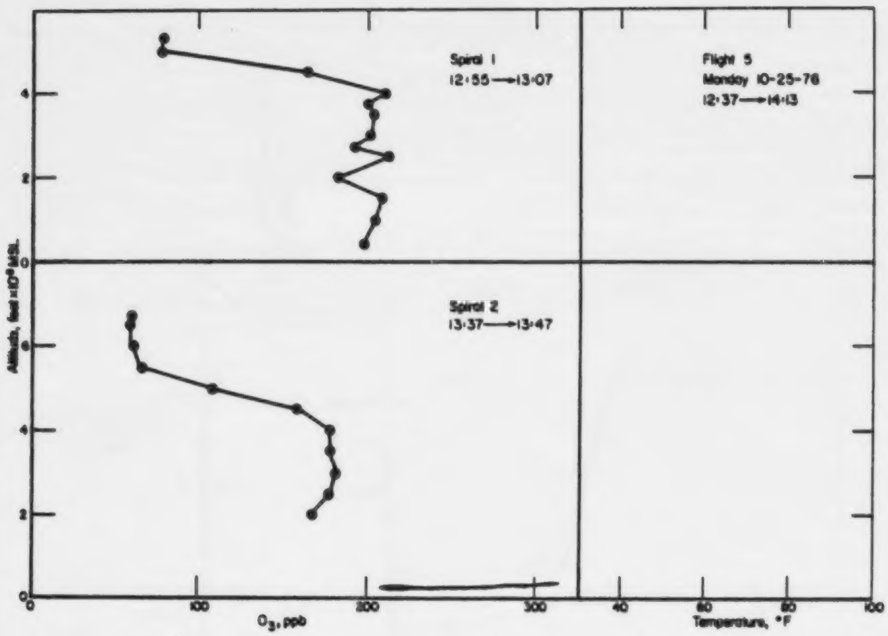


Figure 28B. Vertical profiles from Flight 5, October 25, 1976.

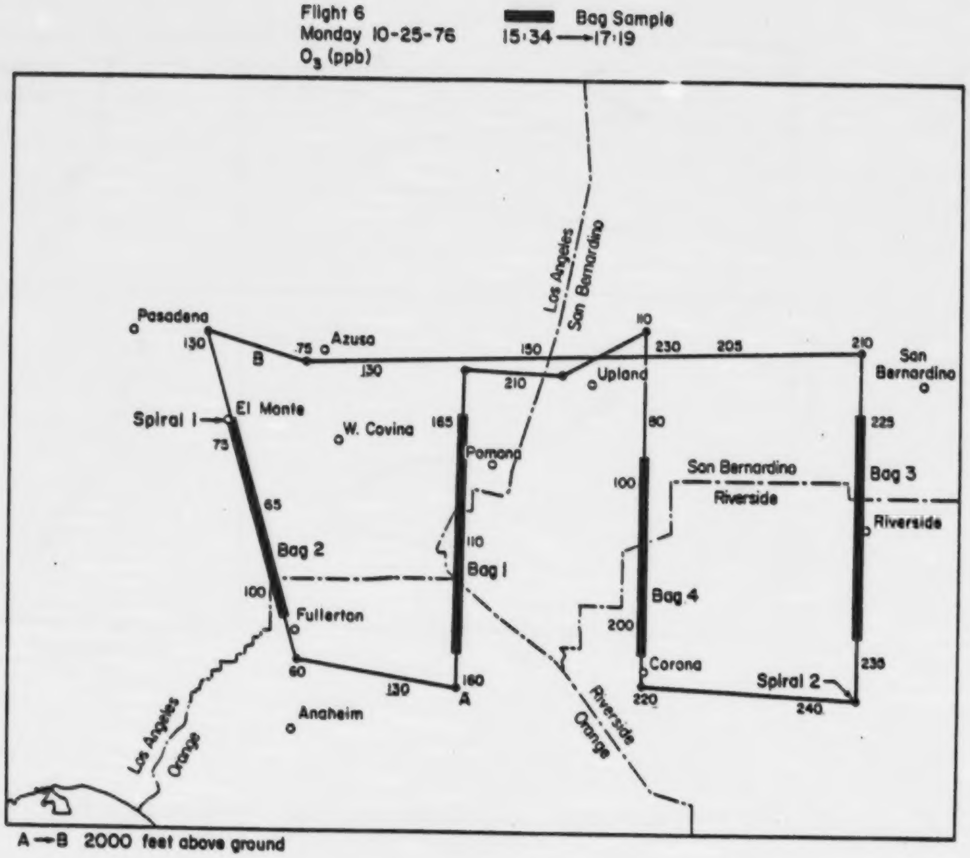

Flight 6
Monday 10-25-76
O_3 (ppb)
Bag Sample
15:34 → 17:19
Los Angeles
San Bernardino
Pasadena
130
B
75
Azusa
130
150
110
230
205
210
San Bernardino
210
Upland
Spiral 1
El Monte
75
W. Covina
165
Pomona
80
225
100
San Bernardino
Riverside
Bag 3
65
Riverside
Bag 2
110
Bag 1
100
Bag 4
Fullerton
200
Corona
235
60
130
160
A
Spiral 2
220
240
Anaheim
Riverside
Orange
Los Angeles
Orange
A → B 2000 feet above ground

Figure 29A. Flight path for Flight 6, October 25, 1976.

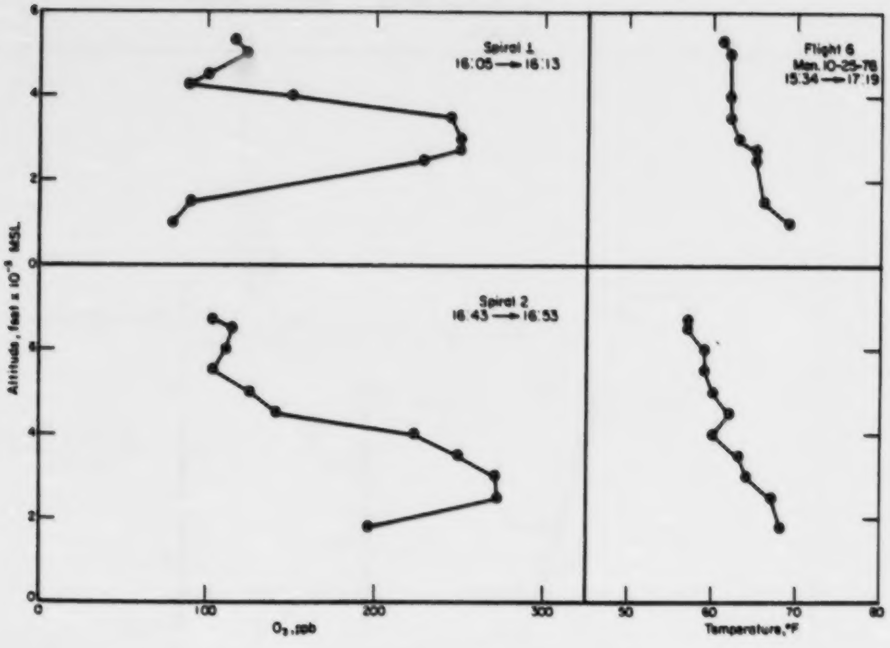


Figure 29B. Vertical profiles from Flight 6, October 25, 1976.

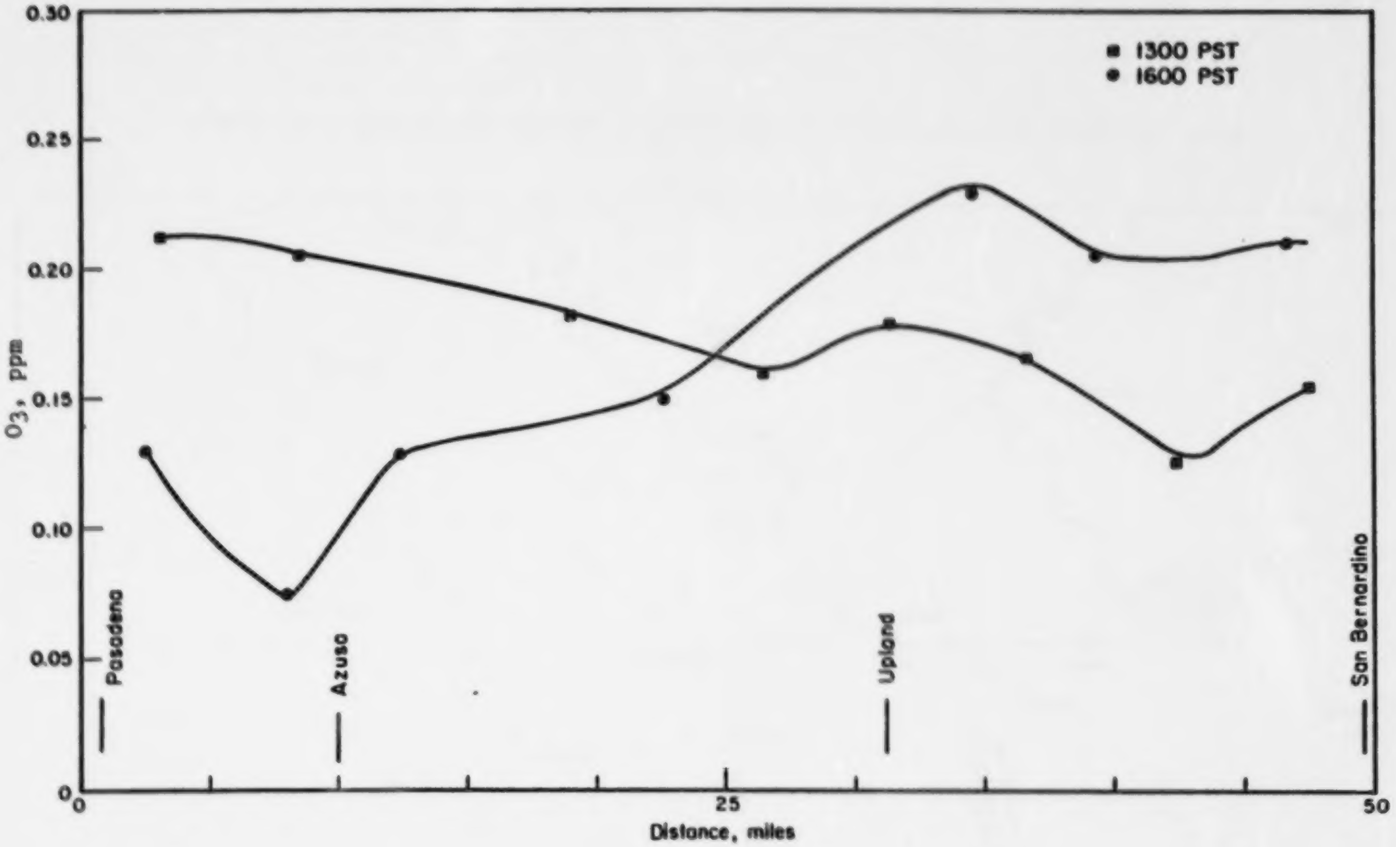


Figure 30. West to east ozone from Flights 5 and 6.

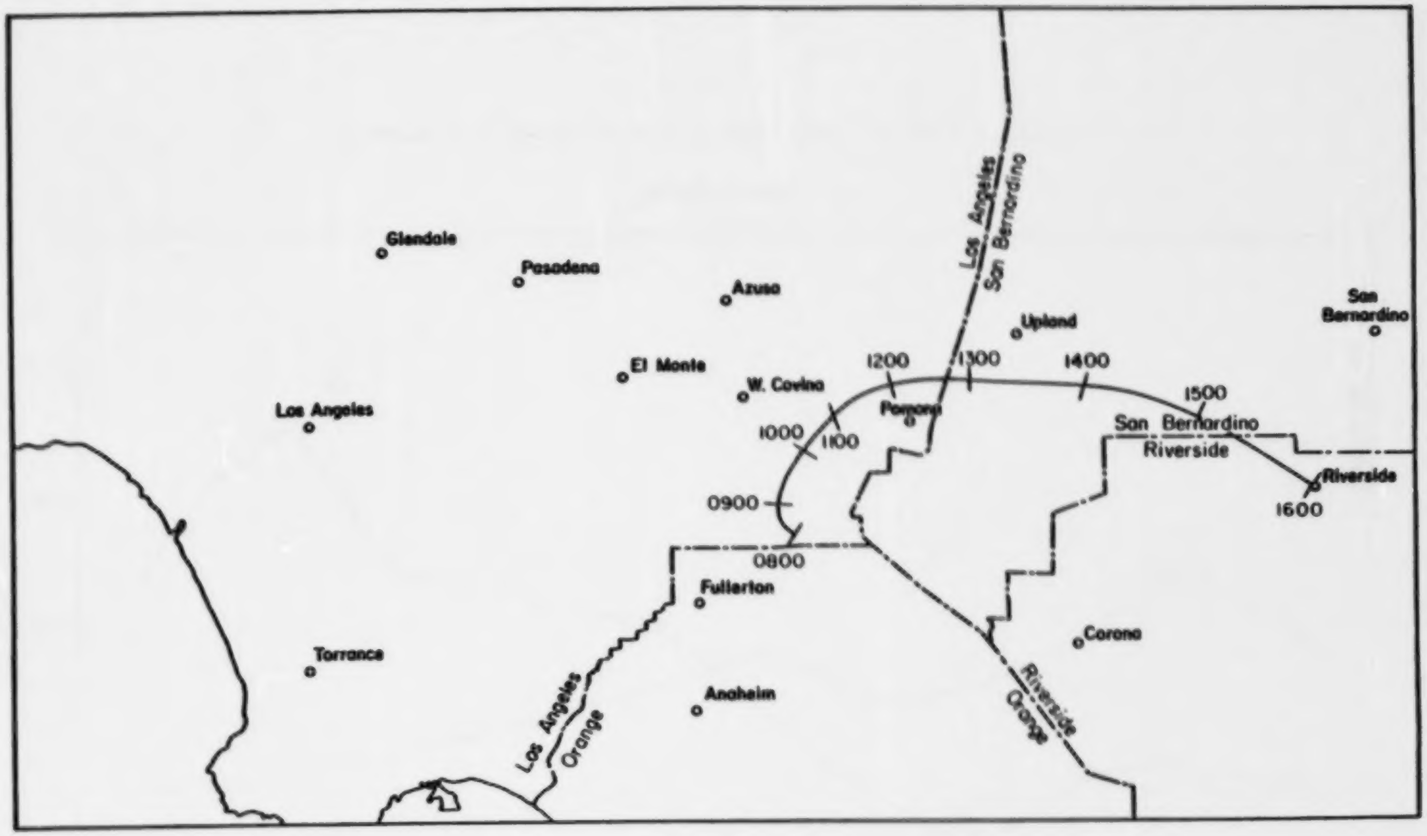

Glendale
Pasadena
Azusa
Los Angeles
San Bernardino
Upland
San Bernardino
El Monte
W. Covina
Los Angeles
Pomona
1200
1300
1400
1500
1000
1100
0900
0800
San Bernardino
Riverside
Riverside
1600
Fullerton
Corona
Torrance
Anaheim
Los Angeles
Orange
Riverside
Orange

Figure 31. Trajectory ending at Riverside at 16:00 PST on October 25, 1976.

vertical profiles from Flight 6, is intriguing. Layering in the Los Angeles air has been discussed in detail in a previous report by Edinger.(17)

Nitrogen Oxides Reactions

Two flights were undertaken on October 25 to investigate NO_x distribution and reaction. The flight patterns were shown in Figures 28 and 29. Integrated bag sample results from these flights were provided in Table 9 and are condensed in Table 24. The north-south traverses along which the samples were collected are labeled by letter from west to east.

The oxidized nitrogen distribution ratio, $\frac{PAN}{NO_x + PAN}$ was variable during Flight 5, ranging from 4 to 16 percent for the three traverses. The sample from the D traverse was lost due to a tear in the sample bag prior to analysis. The PAN conversion percentage for Flight 5 shows an orderly west to east increase from 6 to 20 percent. This is the kind of progression expected for secondary photochemical products generated in a transported air mass; i.e., higher product/precursor ratios in the air which has had the longest time to react. The average wind speed during the day was 5 mph, so the transport time between the locations of the westernmost and easternmost traverses is 8 hours.

The air parcel monitored near Riverside at 16:30 PST (6-D) originated near the westernmost traverse area 8 hours earlier according to the trajectory in Figure 32. Assuming a uniform transport rate, the distribution ratio versus reaction time between traverses has been plotted in Figure 33. The curve suggests a lower limit conversion to PAN at a rate of .02 hr^{-1}.

The rate of NO_x removal can be approximated, subject to all the assumptions discussed earlier, by plotting the tracer/NO_x ratios against reaction time,again setting the western traverse at $t = 0$. The CO/NO_x results from Figure 34 indicate a lower limit rate of ~ 0.04 hr^{-1}, while the C_2H_2/NO_x ratios are too scattered to permit a loss rate estimate. Difficulties in measuring small differences in C_2H_2 concentrations are responsible for the scatter.

TABLE 24. FLIGHT DATA FOR OCTOBER 25, 1976

Flight	Time	Traverse	CO	C_2H_2	NO_x	PAN	CO/NO_x	$\frac{C_2H_2}{NO_x}$	$\frac{PAN}{NO_x + PAN}$
5	~13:00 PST	A	2.02	0.025	0.105	0.017	19.2	0.24	0.14
5		B	1.20	0.018	0.082	0.003	14.6	0.22	0.04
5		C	1.04	0.012	0.068	0.013	15.3	0.18	0.16
6	~16:00 PST	A	1.24	0.017	0.080	0.005	15.5	0.21	0.06
6		B	1.41	0.015	0.102	0.011	13.8	0.15	0.10
6		C	1.72	0.020	0.082	0.016	21.0	0.24	0.16
6		D	1.40	0.013	0.070	0.018	20.0	0.19	0.20

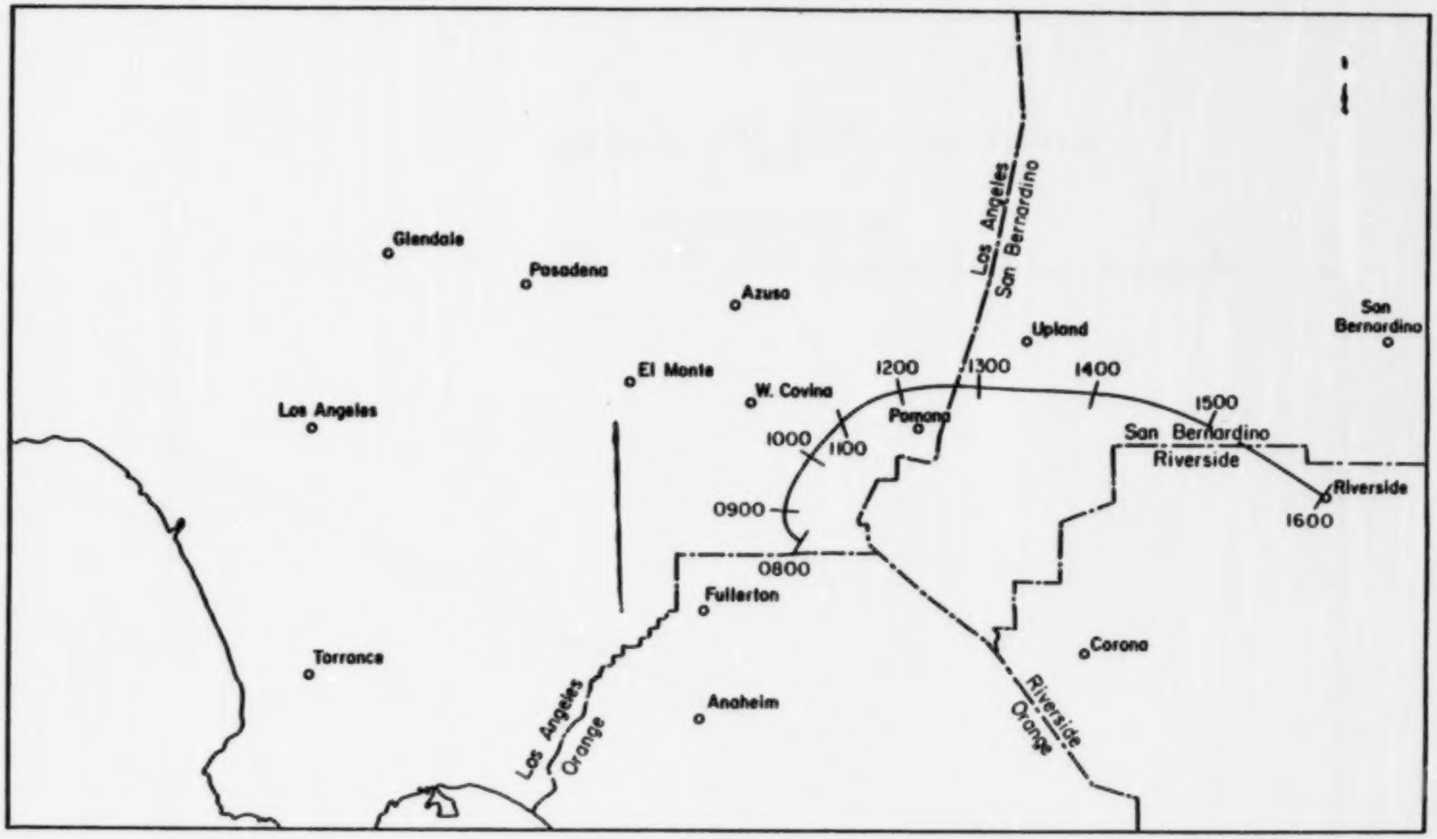

Glendale
Pasadena
Azusa
Los Angeles
San Bernardino
Upland
San Bernardino
El Monte
W. Covina
1200
1300
1400
1500
Los Angeles
Pomona
1000
1100
San Bernardino
Riverside
Riverside
0900
1600
0800
Fullerton
Corona
Torrance
Anaheim
Los Angeles
Orange
Riverside
Orange

Figure 32. Trajectory ending at Riverside at 16:00 PST on October 25, 1976.

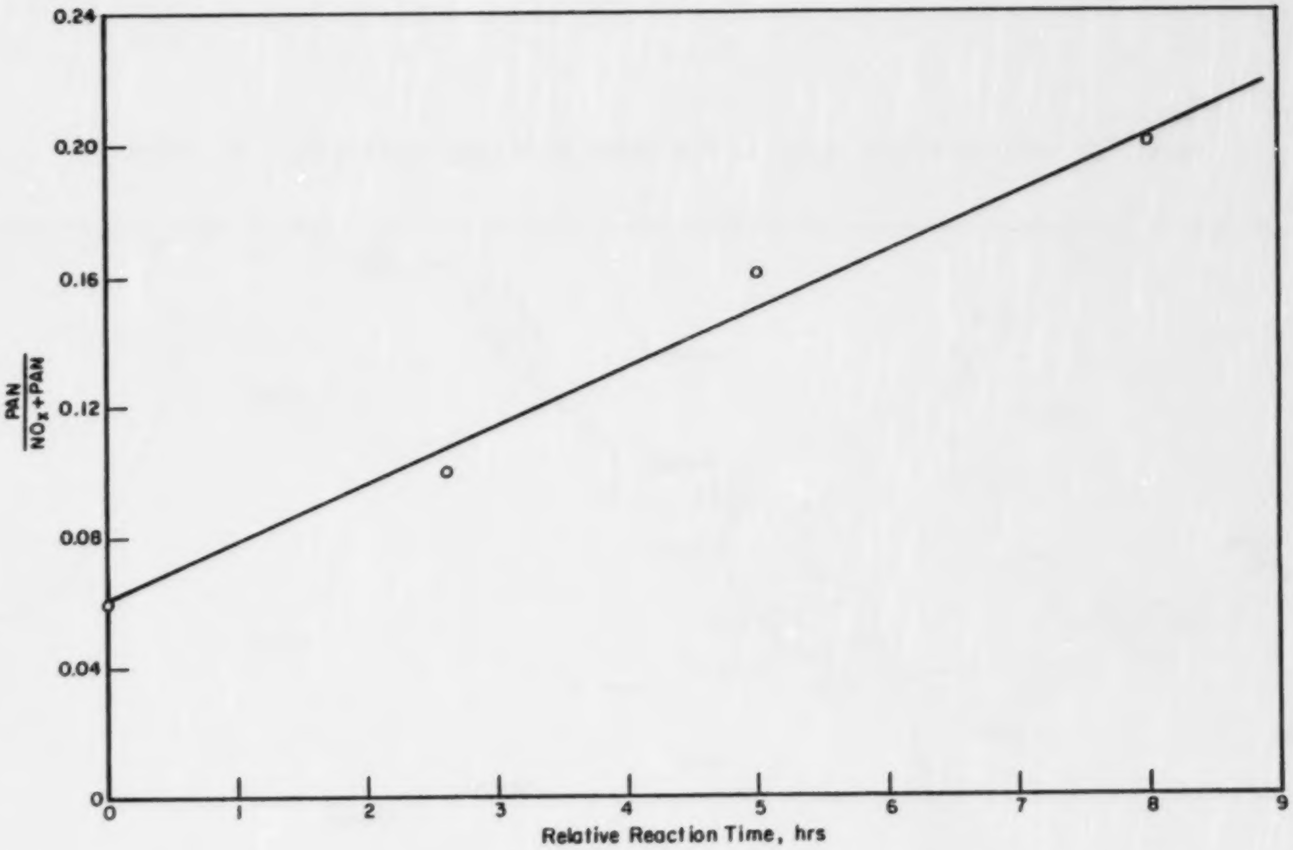


Figure 33. $\frac{PAN}{NO_x + PAN}$ vs reaction time.

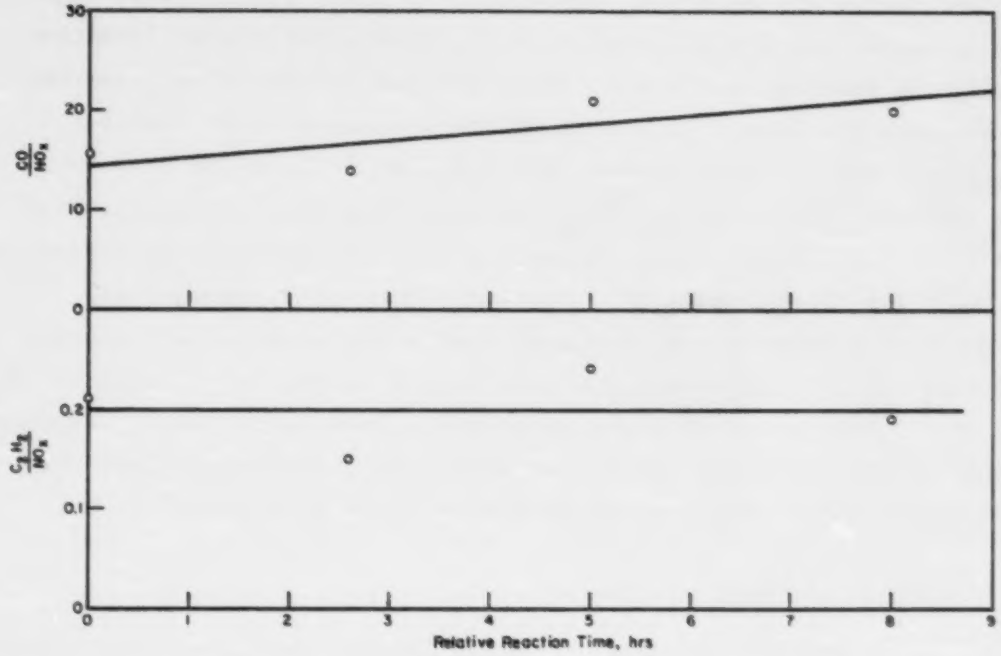


Figure 34. Pollutant ratios for Flight 6.

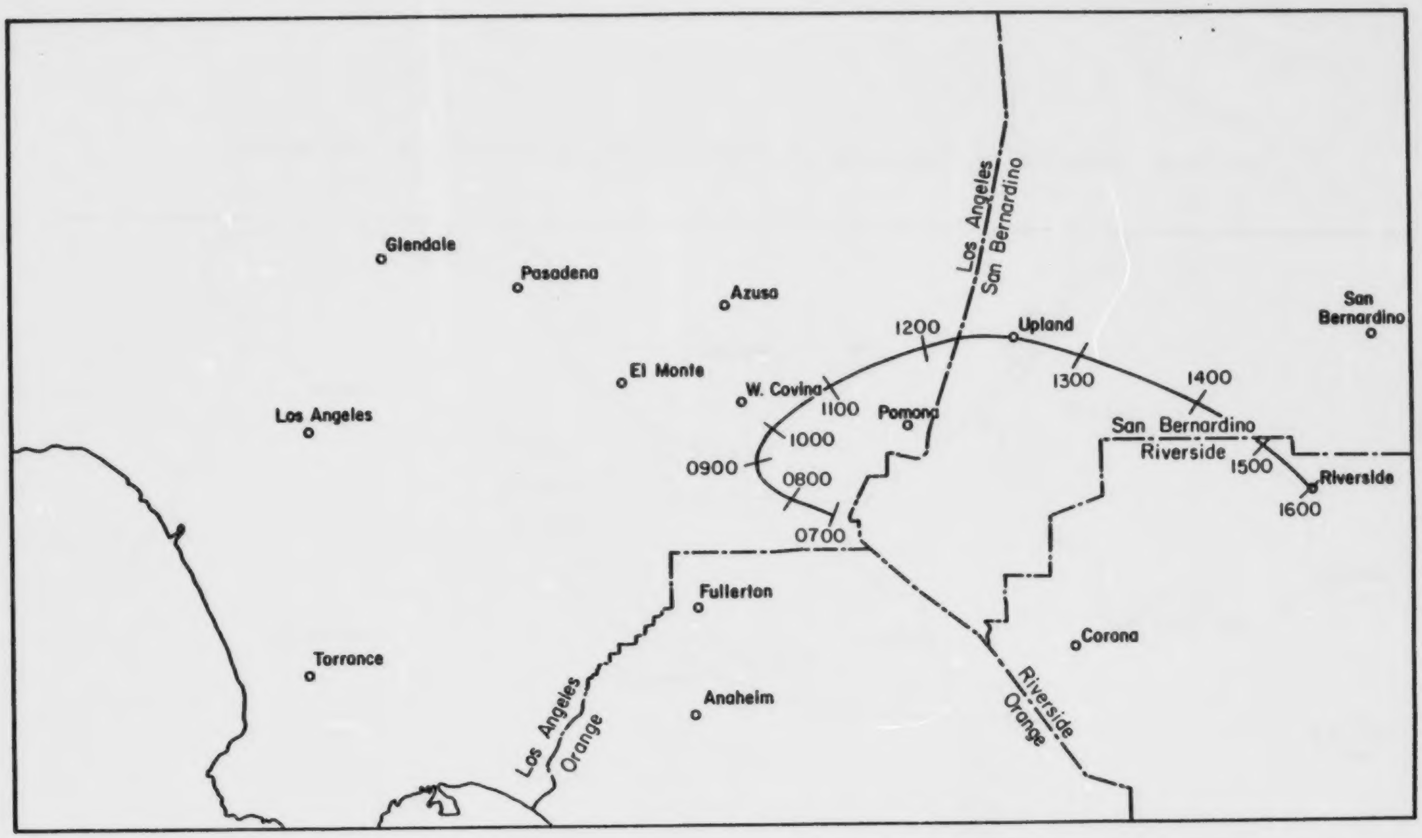
One final estimate of conversion rate is available from the flight data from October 25, 1976. The air mass trajectory in Figure 32 shows that the air monitored during traverse 6-D at 16:30 PST was located at approximately the same position as traverse 5-C at the time the 5-C sample was collected. Therefore, the differences between these two traverses can be used to estimate NO_x removal and product formation during the intervening 3 hours. Since the area between these traverses is sparsely populated, the problem of fresh pollutant injection is minimized, and all three tracers (CO, C_2H_2, and F-11) can be used for the estimate. The ratio $\frac{PAN}{NO_x + PAN}$ increased from 16 to 20 percent over the three hour reaction time, suggesting a 1-2 percent per hour conversion to PAN. The three tracers CO, C_2H_2, and F-11 predict, respectively, 23 percent, 3 percent, and 33 percent loss of NO_x between the traverses. Ignoring the low C_2H_2 result, the data suggest an NO_x removal rate of .08-.11 hr^{-1}. This should still be considered a lower limit, but the Lagrangian nature of the experiment and the low emissions in the area suggest that this result should be a good approximation of the true rate.

CASE STUDY 4: OCTOBER 19, 1976

It was warm and very hazy on 19 October, with one of the highest TSP loadings recorded during the study (203.5 $\mu g/m^3$). This was the third working day of the field study and the aircraft was not yet operational; nevertheless it was selected as a case study day because of the high levels of nitrogen pollutants observed at the ground stations.

Winds were from the west and southwest most of the day. Trajectories for the air parcels arriving in Riverside and Upland at 16:00 PST are shown in Figures 35 and 36. These trajectories will be used later in interpreting the ground station results.

All of the ground station data are included in Appendix A. Concentrations of the pertinent compounds are given in Table 25. Nitrogen oxides concentrations have been corrected for PAN interference. Neither O_3 nor PAN reached high concentrations at Temple City, but both were very high at Upland and Rubidoux in the afternoon. Particulate nitrate was also very high at Rubidoux.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Pasadena
Azusa
Los Angeles
San Bernardino
San Bernardino
Upland
1200
El Monte
1300
1400
W. Covina
1100
Pomona
Los Angeles
1000
San Bernardino
Riverside
0900
0800
1500
Riverside
1600
0700
Fullerton
Corona
Torrance
Anaheim
Los Angeles
Orange
Riverside
Orange

Figure 35. Trajectory ending in Riverside at 1600 PST, 19 October, 1976.

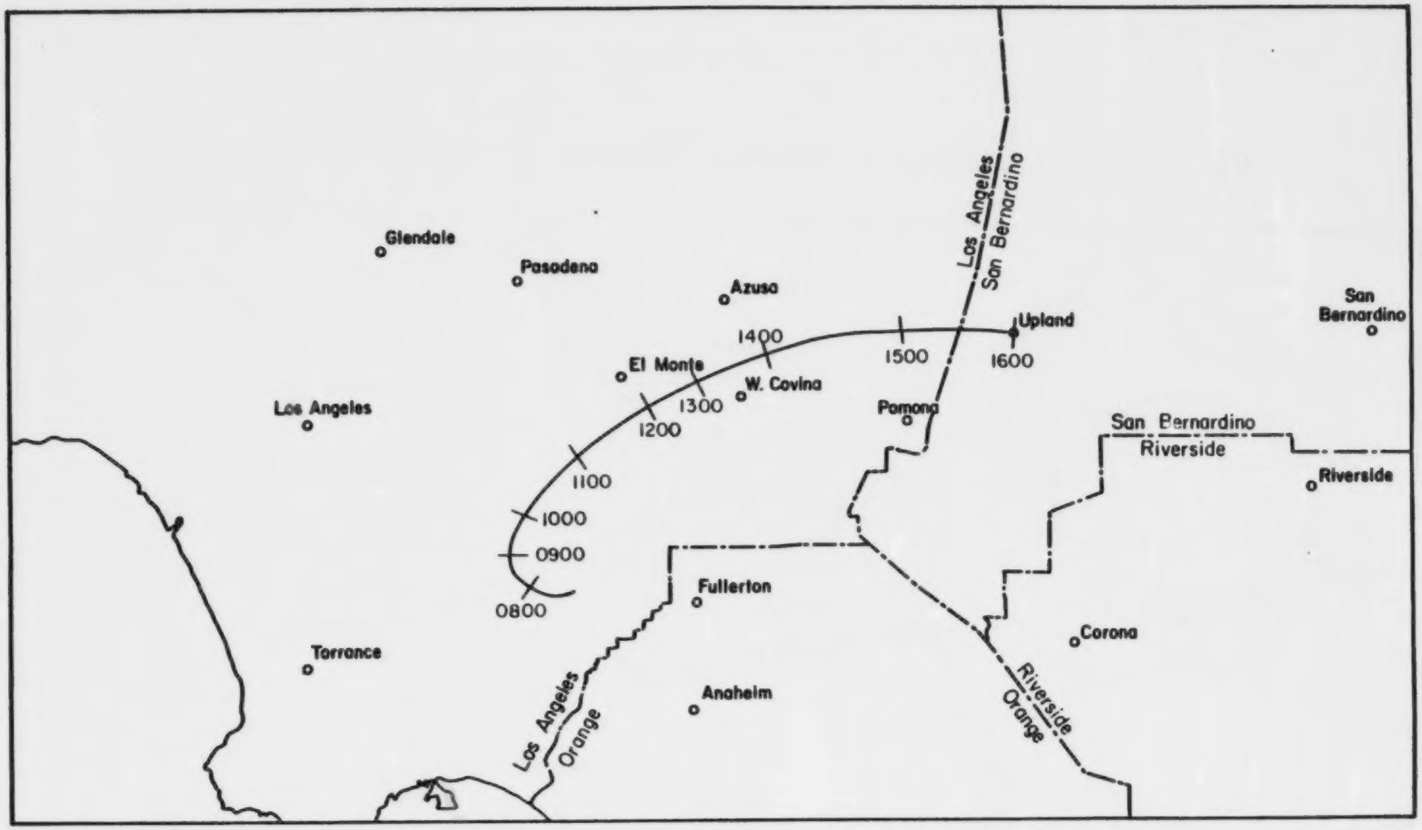
Glendale
Pasadena
Azusa
Los Angeles
San Bernardino
Upland
San Bernardino
El Monte
1400
1500
1600
W. Covina
1300
Los Angeles
Pomona
1200
San Bernardino
Riverside
Riverside
1100
1000
0900
0800
Fullerton
Corona
Torrance
Anaheim
Los Angeles
Orange
Riverside
Orange

Figure 36. Trajectory ending in Upland at 1600 PST, 19 October, 1976.

TABLE 25. GROUND STATION RESULTS FOR OCTOBER 19, 1976

	Time of Day				
Compound	9-11	11-13	13-17	15-17	Average
		Temple City			
O_3	.030	.070	.060	–	.050
NO_x	.095	.095	.114	–	.101
PAN	$\leq$.001	$\leq$.001	.006	–	.002
F-11	317	529	-	–	-
CO	2.80	3.75	4.64	–	3.73
C_2H_2	.025	.040	.058	–	.041
SO_2	.010	.010	.010	–	.010
NO_3^-	NA	NA	NA	–	.0006
$SO_4^=$	NA	NA	NA	–	.008
		Upland			
O_3	.070	.138	.195	.192	.148
NO_x	.060	.050	.029	.020	.042
PAN	.006	.012	.018	.040	.019
F-11	-	-	634	-	-
CO	2.70	2.40	1.90	3.36	2.59
C_2H_2	.028	.021	.016	.033	.025
SO_2	.020	.020	.020	.020	.020
NO_3^-	NA	NA	NA	NA	.0005
$SO_4^=$	NA	NA	NA	NA	.008
		Rubidoux			
O_3	.035	.090	.140	.155	.105
NO_x	.125	.083	.024	.049	.070
PAN	$\leq$.001	.002	.016	.016	.009
F-11	-	-	742	1696	-
CO	2.20	1.85	1.30	2.10	1.86
C_2H_2	.020	.015	.012	.026	.018
SO_2	.010	.020	.020	.030	.020
NO_3^-	NA	NA	NA	NA	.018
$SO_4^=$	NA	NA	NA	NA	.008

Nitrogen Compound Distribution on October 19, 1976

A number of significant ground station ratios for 19 October are presented in Table 26. Averaged over the 8-hour daylight sampling period, the fraction of oxidized nitrogen present as measured reaction products (i.e., $\frac{PAN + NO_3^-}{NO_x + NO_2 + PAN + NO_3^-}$) was 3 percent at Temple City, 32 percent at Upland and 28 percent at Rubidoux. Of the NO_x reaction products, PAN made the greatest contribution at Upland and particulate nitrate at Rubidoux. The ratio of PAN/particulate nitrate averaged 38 at Upland but dropped to 0.5 at Rubidoux. The reasons for increased particulate nitrate contributions at Rubidoux were discussed earlier.

The distribution of sulfur compounds is different from nitrogen, with both SO_2 and $SO_4^=$ uniformly distributed across the basin in contrast to the sharp west-east nitrate gradient. The spatial differences in $SO_4^=$ and NO_3^- distribution are apparent from the ground station ratios in Table 27. The simple $SO_4^=/NO_3^-$ ratios do not agree with the SO_2/NO_x emissions ratio of ~0.2. However, when all the measured sulfur and nitrogen species are taken into account, the measured ratios are much closer to the emissions ratio.

Nitrogen Balance

Both Upland and Rubidoux experienced high levels of photochemical pollutants on 19 October. The expected and measured concentrations of oxidized nitrogen compounds at the two ground stations are compared in Table 28. The expected values are derived from the CO and C_2H_2 tracer concentrations and the 09:00-11:00 PST tracer/NO_x ratio at each site, according to the equation:

$$NO_x \text{ Expected} = \frac{(\text{Tracer})_{\text{measured}}}{\left(\frac{\text{Tracer}}{NO_x}\right)_{\text{unreacted}}}$$

Rather than using emission inventories of uncertain reliability for the tracer/NO_x ratios, the measured early morning ratio* specific to each ground station has been employed. The differences in 09:00-11:00 PST tracer/NO_x

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* Any PAN present during the 0900-1100 PST period is added to NO_x in deriving the tracer/NO_x ratio, to better estimate the unreacted ratio.

TABLE 26. GROUND STATION RATIOS FOR OCTOBER 19, 1976

	Sampling Period				
Ratio	9-11	11-13	13-15	15-17	Average
		Temple City			
CO/NO_x	29.5	39.5	40.7	-	36.6
C_2H_2/NO_x	.26	.42	.51	-	.40
$PAN/(PAN+NO_x)$	.00	.00	.05	-	.02
$\frac{SO_2+SO_4^=}{NO_x+PAN+NO_3^-}$	NA	NA	NA	-	.17
$\frac{PAN+NO_3^-}{NO_x+PAN+NO_3^-}$	NA	NA	NA	-	.03
		Upland			
CO/NO_x	45.0	48.0	65.5	116	68.6
C_2H_2/NO_x	.47	.42	.55	1.13	.64
$PAN/(NO_x+PAN)$	.09	.19	.38	.58	.31
$\frac{SO_2+SO_4^=}{NO_x+PAN+NO_3^-}$	NA	NA	NA	NA	.46
$\frac{PAN+NO_3^-}{NO_x+PAN+NO_3^-}$	NA	NA	NA	NA	.32
		Rubidoux			
CO/NO_x	17.6	22.3	54.2	42.8	34.2
C_2H_2/NO_x	.16	.18	.50	.53	.34
$PAN/(NO_x+PAN)$	.00	.02	.40	.25	.17
$\frac{SO_2+SO_4^=}{NO_x+PAN+NO_3^-}$	NA	NA	NA	NA	.29
$\frac{PAN+NO_3^-}{NO_x+PAN+NO_3^-}$	NA	NA	NA	NA	.28

TABLE 27. MEASURED RATIOS FOR OCTOBER 19, 1976 (Molar)

	Temple City	Upland	Rubidoux
$SO_4^{=}/NO_3^{-}$	13	16	0.44
$\frac{SO_2+SO_4^{=}}{NO_x+PAN+NO_3^{-}}$	.17	.46	.29

TABLE 28. COMPARISON OF EXPECTED AND MEASURED NITROGEN COMPOUND CONCENTRATIONS FOR OCTOBER 19, 1976

Time (PST)	NO_x Predicted By: CO	C_2H_2	Measured Nitrogen Compounds*
		Upland	
11:00-13:00	.058	.051	.062
13:00-15:00	.042	.034	.047
15:00-17:00	.075	.070	.065
		Rubidoux	
11:00-13:00	.105	.094	.094**
13:00-15:00	.074	.075	.067**
15:00-17:00	.119	.162	.092**

* $NO + NO_2 + PAN + NO_3^- + HONO_2$

**In deriving these values, the 8-hour NO_3^- concentration was partitioned such that the afternoon to morning concentration ratio was 3.0.

ratios among the three sites is surprising. In general, the site to site variations in these ratios on other days were not nearly as great as observed on the morning of 19 October. While the reason for the differences is not apparent, the use of morning ratios to predict afternoon concentrations should not be affected since each site should be internally consistent. The derivation of expected NO_x concentrations is subject to all the assumptions and uncertainties discussed under Case Study No. 1.

In spite of all the uncertainties inherent in the predicted NO_x concentrations, the rather close nitrogen mass balance observed for all time periods provides some confidence that the important nitrogen compounds are being taken into account. Low concentrations of nitric acid below the instrumental detection limit are included in the "measured" column of the nitrogen balance since nitric acid is measured as NO_2 by the chemiluminescence instrument.(18) The mass balance is not quite as good at Rubidoux as at Upland, possibly due to deposition, since losses to the surface should be more important for Rubidoux due to the longer transport from the source area.

The nitrogen mass balance can also be viewed as a percentage, as in Table 29. In this table, the fractional NO_x deficit based on each tracer is compared with F_N, the fraction of measured nitrogen existing as reaction products. If all the important nitrogen compounds are accounted for and if the assumptions inherent in the NO_x loss calculation are valid, then the percentage loss should equal the percentage observed as reaction products (except for a small loss due to deposition). The tabulated values are indeed in fairly close agreement in most cases. These percentages will be used in the next section to estimate loss and transformation rates.

NO_x Reaction Rate

Using the NO_x loss and reaction product percentages from Table 29 and estimated reaction times from the trajectories in Figures 35 and 36, rate constants can be estimated for NO_x removal and NO_x transformation to reaction products. Because of the higher accuracy associated with the CO measurements, the NO_x losses based on CO will be used. Since the trajectories suggest that all the air parcels in question were laden with primary pollutants by 08:00 PST, reaction time will be defined from 08:00 PST to the

TABLE 29. PERCENT NO_X LOSS COMPARED TO F_N

Time (PST)	NO_x Loss(%) Based on:		F_N* (%)
	CO	C_2H_2	
		Upland	
11:00-13:00	15	0	19
13:00-15:00	38	24	38
15:00-1700	65	63	58
		Rubidoux	
11:00-13:00	21	11	12**
13:00-15:00	68	68	64**
15:00-17:00	59	70	47**

$$^{*}F_N = \frac{PAN+NO_3^-}{NO+NO_2+PAN+NO_3^-}$$

**In deriving these values, the 8 hour NO_3^- concentration was partitioned such that the afternoon to morning concentration ratio was 3.0.

midpoint of each sampling interval. The estimated loss and transformation rate constants are shown for each sampling period at Upland and Rubidoux in Table 30.

Both the NO_x loss and the transformation rate constants average 6-8 percent per hour during the peak photochemical period from 11:00 PST to 17:00 PST. This is the same value reported for Temple City on November 10 and it falls between the Upland and Rubidoux values for November 10. There appears to be a trend toward more rapid losses and transformations in mid-afternoon, paralleling photochemical activity as reflected by ozone concentrations. These conversion rate estimates are higher than those observed in a study of NO_x reactions in the Phoenix, Arizona urban plume(19). That report should be consulted for a discussion of the Phoenix results and comparison with kinetic model estimates.

TABLE 30. ESTIMATED NO_x TRANSFORMATION RATE CONSTANTS FOR OCTOBER 19, 1976

Time (PST)	NO_x Loss (hr^{-1})	Product Formation (hr^{-1})
	Upland	
11:00-13:00	∿.04	∿.05
13:00-15:00	∿.06	∿.06
15:00-17:00	∿.08	∿.07
	Rubidoux	
11:00-13:00	∿.05	∿.03
13:00-15:00	∿.11	∿.11
15:00-17:00	∿.07	∿.06

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APPENDIX A

GROUND STATION DATA FROM LOS ANGELES FIELD PROGRAM

TEMPLE CITY

OCTOBER 15, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	.010	.010	≤ .005
O3 - PPM	.035	.070	.115	.035	.064
NO - PPM	.010	≤ .005	≤ .005	.015	.006
NOX - PPM	.055	.070	.070	.100	.074
PAN - PPM	.004	-.006	-.008	.010	.007
FREON 11 -PPT	846.	-1.	-1.	-1.	-1.
CO - PPM	2.54	3.07	-3.45	3.82	3.22
CH4 - PPMC	2.92	2.59	-3.21	3.82	3.13
C2H2 - PPMC	.030	.030	-.037	.043	.035

TEMPLE CITY

OCTOBER 18, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.010	.010	.010	.015	.011
O3 - PPM	.025	.070	.080	.030	.051
NO - PPM	.030	≤ .005	≤ .005	.025	.014
NOX - PPM	.095	.055	.055	.105	.078
PAN - PPM	≤ .001	≤ .001	.002	.002	≤ .001
FREON 11 -PPT	421.	421.	-1.	-1.	-1.
CO - PPM	3.25	2.10	2.30	3.55	2.80
CH4 - PPMC	2.74	2.20	2.42	2.37	2.43
NMHC - PPMC	-1.00	-1.00	1.98	1.98	-1.00
C2H2 - PPMC	.020	.030	.025	.037	.028
C2H4 - PPMC	.040	.018	.150	.150	.090

TEMPLE CITY

OCTOBER 19, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.010	-.010	.010	.010	.010
O3 - PPM	.030	.070	.095	.020	.054
NO - PPM	.015	≤ .005	≤ .005	.025	.010
NOX - PPM	.095	.095	.095	.145	.108
PAN - PPM	≤ .001	≤ .001	.006	.006	.003
FREON 11 -PPT	317.	529.	-1.	-1.	-1.
CO - PPM	2.80	3.75	4.64	4.64	3.96
CH4 - PPMC	2.52	2.45	2.45	2.45	2.47
NMHC - PPMC	1.38	2.16	-1.00	-1.00	-1.00
C2H2 - PPMC	.025	.040	.058	.058	.045
C2H4 - PPMC	.055	.068	-1.000	-1.000	-1.000

TEMPLE CITY

OCTOBER 20, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.025	.030	.015	.010	.020
O3 - PPM	.005	.020	.015	.005	.011
NO - PPM	.130	.045	.025	.045	.061
NOX - PPM	.265	.195	.155	.205	.205
PAN - PPM	≤ .001	.002	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	529.	425.	317.	-1.	424.
CO - PPM	6.60	6.00	5.10	5.70	5.85
CH4 - PPMC	3.52	3.03	2.83	2.65	3.01
NMHC - PPMC	2.82	2.56	2.00	2.14	2.38
C2H2 - PPMC	.080	.070	.040	.030	.055

TEMPLE CITY

OCTOBER 21, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.010	.010	.010	.010	.010
O3 - PPM	.025	.035	.065	.025	.038
NO - PPM	.015	.010	≤ .005	.015	.010
NOX - PPM	.090	.095	.080	.100	.091
PAN - PPM	≤ .001	≤ .001	.006	≤ .001	.002
FREON 11 -PPT	796.	371.	-423.	475.	516.
CO - PPM	2.88	3.30	2.70	3.46	3.09
CH4 - PPMC	2.55	2.45	2.20	2.08	2.32
NMHC - PPMC	1.40	1.55	1.55	1.25	1.44
C2H2 - PPMC	.035	.039	.028	.033	.034
C2H4 - PPMC	.120	.093	.080	.055	.087

TEMPLE CITY

OCTOBER 22, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	.010	.010	≤ .005
O3 - PPM	≤ .002	.020	.025	.010	.014
NO - PPM	.030	.010	.015	.015	.018
NOX - PPM	.085	.075	.060	.085	.076
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	3046.	940.	396.	396.	1194.
CO - PPM	2.50	2.38	2.40	2.40	2.42
CH4 - PPMC	2.43	2.00	1.94	1.64	2.03
NMHC - PPMC	2.05	1.30	.96	.96	1.32
C2H2 - PPMC	.022	.022	.030	.030	.026

TEMPLE CITY

OCTOBER 25, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.010	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.030	.070	.075	.020	.049
NO - PPM	.015	≤ .005	≤ .005	.015	.008
NOX - PPM	.075	.050	.085	.095	.076
PAN - PPM	.002	.004	.008	≤ .001	.004
FREON 11 -PPT	3377.	3445.	994.	598.	2103.
CO - PPM	2.68	2.20	3.12	3.26	2.62
CH4 - PPMC	2.30	2.26	2.33	2.04	2.23
NMHC - PPMC	1.29	1.06	1.13	1.17	1.16
C2H2 - PPMC	.040	.034	.038	.043	.039
C2H4 - PPMC	-1.000	.065	.066	.059	.063

TEMPLE CITY

OCTOBER 26, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.015	.020	.020	.005	.015
NO - PPM	.040	≤ .005	≤ .005	≤ .005	.010
NOX - PPM	.110	.015	.010	.030	.041

TEMPLE CITY

OCTOBER 27, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.010	.010	≤ .005	≤ .005	≤ .005
O3 - PPM	.005	.025	.035	.010	.019
NO - PPM	.085	.020	≤ .005	.040	.036
NOX - PPM	.175	.105	.075	.140	.124

TEMPLE CITY

OCTOBER 28, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	.010	.015	.006
O3 - PPM	-.005	-.025	.030	≤ .002	.015
NO - PPM	.055	.020	.015	.055	.036
NOX - PPM	.140	.110	.125	.130	.126
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	1951.	1325.	1390.	994.	1415.
CO - PPM	2.83	2.20	2.50	3.12	2.66
CH4 - PPMC	2.30	2.22	2.24	1.95	2.18
NMHC - PPMC	1.30	1.03	1.01	1.22	1.14
C2H2 - PPMC	.044	.038	.038	.045	.041
C2H4 - PPMC	.063	.062	.049	.055	.057

TEMPLE CITY

OCTOBER 29, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO_2 - PPM	.010	.020	.025	.025	.020
O_3 - PPM	.005	.035	.045	.020	.026
NO - PPM	.070	.025	.010	.025	.033
NOX - PPM	.150	.110	.125	.190	.144
PAN - PPM	≤ .001	≤ .001	.002	.004	.002
FREON 11 -PPT	644.	662.	727.	878.	728.
CO - PPM	2.80	2.35	2.65	4.70	3.13
CH_4 - PPMC	2.23	2.22	2.24	2.58	2.32
NMHC - PPMC	1.32	1.08	1.24	1.98	1.41
C_2H_2 - PPMC	.043	.030	.040	.070	.046
C_2H_4 - PPMC	.048	.050	.057	.082	.059

TEMPLE CITY

NOVEMBER 1, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.035	.080	≤ .005	≤ .005	.029
O3 - PPM	.010	.035	.030	.035	.028
NO - PPM	.045	.020	.010	≤ .005	.019
NOX - PPM	.140	.070	.055	.105	.093
PAN - PPM	≤ .001	≤ .001	≤ .001	.002	≤ .001
FREON 11 -PPT	1174.	1076.	796.	882.	982.
CO - PPM	2.65	1.95	1.45	2.45	2.13
CH4 - PPMC	2.17	1.90	1.92	2.10	2.02
NMHC - PPMC	1.21	.86	.56	1.10	.93
C2H2 - PPMC	.043	.030	.020	.040	.033
C2H4 - PPMC	-1.000	.078	.060	.070	.069

TEMPLE CITY

NOVEMBER 2, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.015	.010	.010	-.010	.011
O3 - PPM	.005	.040	.045	.040	.033
NO - PPM	.045	.010	≤ .005	≤ .005	.014
NOX - PPM	.110	.065	.055	.110	.085
PAN - PPM	≤ .001	≤ .001	.001	.001	≤ .001
FREON 11 -PPT	695.	547.	479.	479.	550.
CO - PPM	2.17	1.48	2.00	2.00	1.91
CH4 - PPMC	2.13	1.95	1.89	1.89	1.97
NMHC - PPMC	1.17	.82	1.19	1.19	1.09
C2H2 - PPMC	.031	.025	.026	.026	.027
C2H4 - PPMC	.068	.051	.055	.055	.057

TEMPLE CITY

NOVEMBER 3, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.005	.035	.030	.010	.020
NO - PPM	.055	≤ .005	.015	.020	.023
NOX - PPM	.180	.050	.075	.160	.116
PAN - PPM	≤ .001	≤ .001	≤ .001	.002	≤ .001
FREON 11 -PPT	1058.	828.	583.	893.	841.
CO - PPM	3.00	1.60	2.00	4.10	2.68
CH4 - PPMC	2.15	1.94	1.87	2.25	2.05
NMHC - PPMC	1.52	.86	.76	1.92	1.27
C2H2 - PPMC	.045	.024	.020	.060	.037
C2H4 - PPMC	.095	.060	.051	.094	.075

TEMPLE CITY

NOVEMBER 4, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.005	.025	.045	.055	.033
NO - PPM	.045	≤ .005	≤ .005	≤ .005	.011
NOX - PPM	.110	.030	.035	.095	.068
PAN - PPM	≤ .001	≤ .001	≤ .001	.004	≤ .001
FREON 11 -PPT	680.	576.	770.	886.	728.
CO - PPM	2.50	.78	.97	2.03	1.57
CH4 - PPMC	2.03	1.90	1.85	2.01	1.95
NMHC - PPMC	2.17	1.14	.69	1.07	1.27
C2H2 - PPMC	.045	-.029	.013	.025	.028
C2H4 - PPMC	.087	.045	.040	.065	.059

TEMPLE CITY

NOVEMBER 5, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.005	≤ .002	≤ .002	.010	.004
NO - PPM	.025	.015	.010	.015	.016
NOX - PPM	.090	.050	.045	.115	.075
PAN - PPM	≤ .001	≤ .001	≤ .001	.002	≤ .001
FREON 11 -PPT	580.	421.	403.	648.	513.
CO - PPM	2.22	1.56	1.10	2.60	1.87
CH4 - PPMC	2.02	1.85	1.78	2.00	1.91
NMHC - PPMC	1.30	.90	.27	.94	.85
C2H2 - PPMC	.038	.025	.018	.032	.028

TEMPLE CITY

NOVEMBER 8, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.015	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.005	.020	.045	.035	.026
NO - PPM	.035	.010	≤ .005	≤ .005	.011
NOX - PPM	.130	.070	.060	.140	.100
PAN - PPM	≤ .001	≤ .001	.002	.010	.003
FREON 11 -PPT	846.	929.	860.	695.	832.
CO - PPM	2.50	1.70	1.20	3.37	2.19
CH4 - PPMC	2.20	1.94	2.00	2.26	2.10
NMHC - PPMC	1.23	.63	1.06	2.10	1.26
C2H2 - PPMC	.042	.024	.020	.046	.033

TEMPLE CITY

NOVEMBER 9, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.015	.020	-.020	.040	.024
O3 - PPM	.005	.050	.075	.055	.046
NO - PPM	.095	.020	≤ .005	≤ .005	.029
NOX - PPM	.180	.135	.120	.135	.143
PAN - PPM	≤ .001	.002	.010	.008	.005
FREON 11 -PPT	1094.	1094.	911.	1274.	1094.
CO - PPM	3.56	3.19	2.91	3.24	3.23
CH4 - PPMC	2.58	2.51	2.29	2.44	2.46
NMHC - PPMC	1.72	1.52	1.38	1.66	1.57
C2H2 - PPMC	.050	.045	.039	.043	.044
C2H4 - PPMC	.085	.078	.065	.068	.074

TEMPLE CITY

NOVEMBER 10, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.025	.025	-.025	.030	.026
O3 - PPM	.015	.070	.095	.065	.061
NO - PPM	.070	≤ .005	≤ .005	≤ .005	.018
NOX - PPM	.215	.120	.135	.120	.148
PAN - PPM	≤ .001	.008	.024	.023	.014
FREON 11 -PPT	1159.	828.	1015.	713.	929.
CO - PPM	5.00	3.40	3.75	3.70	3.96
CH4 - PPMC	3.08	2.70	2.78	2.50	2.77
NMHC - PPMC	2.42	1.73	1.95	1.89	2.00
C2H2 - PPMC	.070	.050	.055	.055	.058
C2H4 - PPMC	.080	.080	.080	.066	.077

TEMPLE CITY

NOVEMBER 11, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.020	.010	.010	≤ .005	.010
O3 - PPM	.005	.015	.010	≤ .002	.008
NO - PPM	.025	.015	.015	.050	.026
NOX - PPM	.060	.055	.060	.105	.075
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	601.	479.	382.	464.	482.
CO - PPM	2.57	1.90	1.60	2.35	2.11
CH4 - PPMC	2.27	2.15	2.03	2.10	2.14
NMHC - PPMC	1.21	.87	.62	1.02	.93
C2H2 - PPMC	.036	.026	.026	.037	.031
C2H4 - PPMC	.060	.058	.048	.063	.057

TEMPLE CITY

NOVEMBER 12, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	-.010	.010	.010	.010	.010
O3 - PPM	≤ .002	.010	.005	≤ .002	.004
NO - PPM	.050	.015	.020	.055	.035
NOX - PPM	.095	.045	.070	.110	.080
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	439.	313.	306.	288.	337.
CO - PPM	2.55	1.27	1.60	2.30	1.93
CH4 - PPMC	2.08	2.01	2.00	2.09	2.05
NMHC - PPMC	1.11	.59	.78	.96	.86
C2H2 - PPMC	.042	.015	.024	.035	.029
C2H4 - PPMC	.045	.041	.042	.042	.043

TEMPLE CITY

NOVEMBER 15, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	.010	.015	.006
O3 - PPM	≤ .002	.015	.030	.020	.016
NO - PPM	.040	.020	.015	.025	.025
NOX - PPM	.095	.030	.095	.165	.109
PAN - PPM	≤ .001	≤ .001	.001	.005	.002
FREON 11 -PPT	522.	547.	770.	1159.	750.
CO - PPM	2.24	1.95	2.25	3.90	2.59
CH4 - PPMC	2.15	2.03	2.30	2.60	2.27
NMHC - PPMC	1.23	.90	1.00	2.02	1.29
C2H2 - PPMC	.033	.027	.028	.068	.039
C2H4 - PPMC	.065	.050	.040	.082	.059

TEMPLE CITY

1976 FIELD PROGRAM AVERAGES

	9 - 11	11 - 13	13 - 15	15 - 17	GRAND AVERAGE
SO2 - PPM	.010	.011	.008	.010	.010
O3 - PPM	.011	.035	.046	.023	.029
NO - PPM	.047	.012	.007	.020	.021
NOX - PPM	.125	.079	.079	.122	.101
PAN - PPM	≤ .001	.001	.004	.004	.002
FREON 11 -PPT	1039.	829.	678.	733.	820.
CO - PPM	2.99	2.41	2.48	3.34	2.80
CH4 - PPMC	2.42	2.22	2.22	2.30	2.29
NMHC - PPMC	1.55	1.20	1.12	1.48	1.34
C2H2 - PPMC	.041	.033	.031	.043	.037
C2H4 - PPMC	.070	.060	.063	.072	.066

CABLE AIRPORT

OCTOBER 15, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.502	.633	.495	.196	.457
WIND SPEED - MPH	4.28	7.70	5.10	7.04	6.03
WIND DIR - DEG	217.	226.	239.	261.	236.
TEMP - DEG C	20.6	23.5	25.2	22.7	23.0
RH - %	68.9	56.4	49.9	50.6	56.4
SO2 - PPM	≤ .010	≤ .010	≤ .010	.020	≤ .010
O3 - PPM	.106	.195	.254	.259	.201
NO - PPM	≤ .005	-.015	.030	≤ .005	.011
NOX - PPM	.011	-.032	.053	.033	.032
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	.010	.022	.032	.026	.023
FREON 11 -PPT	425.	-371.	317.	-1.	371.
CO - PPM	2.33	2.65	2.23	2.17	2.35
CH4 - PPMC	2.32	2.36	2.48	2.43	2.40
NMHC - PPMC	-1.00	-1.00	.30	.39	-1.00
C2H2 - PPMC	.026	.017	.022	.022	.022

CABLE AIRPORT

OCTOBER 18, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.118	.348	.456	.222	.286
WIND SPEED - MPH	4.05	4.90	5.86	6.80	5.40
WIND DIR - DEG	192.	257.	273.	260.	245.
TEMP - DEG C	17.5	19.9	22.6	21.3	20.3
RH - %	82.3	69.6	57.3	57.4	66.6
SO2 - PPM	≤ .010	≤ .010	.015	.020	.014
O3 - PPM	.083	.125	.138	.155	.125
NO - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.046	.033	.038	.035	.038
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	.008	≤ .005	≤ .005
PAN - PPM	.028	.014	.012	.014	.017
CO - PPM	2.00	1.80	1.10	1.65	1.64
CH4 - PPMC	2.20	2.25	2.10	2.15	2.18
NMHC - PPMC	.84	.65	.40	.95	.71
C2H2 - PPMC	≤ .002	.004	.008	.015	.007
C2H4 - PPMC	≤ .002	.004	.010	-1.000	.005

CABLE AIRPORT

OCTOBER 19, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.547	.600	.405	.057	.412
WIND SPEED - MPH	3.27	4.78	6.88	7.03	5.49
WIND DIR - DEG	195.	212.	274.	279.	240.
TEMP - DEG C	21.4	26.3	25.4	23.4	24.1
RH - %	66.1	45.7	44.2	50.4	51.6
SO2 - PPM	.020	.020	.020	.020	.020
O3 - PPM	.070	.138	.195	.192	.148
NO - PPM	.006	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.066	.062	.047	.069	.061
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	.006	.012	.018	.040	.019
FREON 11 -PPT	-1.	-1.	634.	-1.	-1.
CO - PPM	2.70	2.40	1.90	3.36	2.59
CH4 - PPMC	2.26	2.21	2.15	2.35	2.24
NMHC - PPMC	1.10	.64	.75	1.04	.88
C2H2 - PPMC	.028	.021	.016	.033	.025
C2H4 - PPMC	.033	.032	.016	.040	.030

CABLE AIRPORT

OCTOBER 20, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.274	.228	.245	.113	.215
WIND SPEED - MPH	3.49	2.82	10.76	4.78	5.46
WIND DIR - DEG	160.	196.	244.	172.	193.
TEMP - DEG C	21.8	24.9	23.7	25.1	23.9
RH - %	54.7	42.2	47.1	34.6	44.7
SO2 - PPM	.015	.020	.020	≤ .010	.016
O3 - PPM	.028	.065	.066	.042	.055
NO - PPM	.051	.005	≤ .005	.020	.019
NOX - PPM	.151	.091	.079	.047	.092
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	.004	.008	.004	≤ .001	.004
CO - PPM	4.35	3.25	1.80	2.30	2.93
CH4 - PPMC	2.55	2.22	2.10	1.84	2.18
NMHC - PPMC	1.25	1.06	.41	.36	.77
C2H2 - PPMC	.035	.028	.017	.024	.026
C2H4 - PPMC	.051	.032	.020	.034	.034

CABLE AIRPORT

OCTOBER 21, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.313	.544	.483	.155	.374
WIND SPEED - MPH	7.10	5.60	7.07	9.13	7.22
WIND DIR - DEG	274.	264.	263.	253.	264.
TEMP - DEG C	19.6	23.3	24.5	21.4	22.2
RH - %	82.0	62.6	56.2	63.8	66.1
SO2 - PPM	≤ .010	.020	≤ .010	≤ .010	.013
O3 - PPM	.056	.117	.163	.149	.121
NO - PPM	.005	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.030	.027	.037	.037	.033
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	≤ .001	.006	.008	.006	.005
FREON 11 -PPT	-1.	-1.	637.	450.	-1.
CO - PPM	1.40	1.46	1.68	1.80	1.59
CH4 - PPMC	2.15	1.98	2.13	2.08	2.09
NMHC - PPMC	.50	.92	.77	.82	.75
C2H2 - PPMC	.013	.008	.019	.019	.015
C2H4 - PPMC	.027	.004	.014	.015	.015

CABLE AIRPORT

OCTOBER 22, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.382	.572	.348	.099	.351
WIND SPEED - MPH	6.98	7.58	10.35	11.15	9.02
WIND DIR - DEG	241.	244.	278.	263.	256.
TEMP - DEG C	18.9	21.4	20.1	17.0	19.4
RH - %	78.3	66.8	64.3	71.2	70.2
SO2 - PPM	.015	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.059	.103	.099	.078	.085
NO - PPM	.009	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.023	.020	.012	.006	.015
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	.002	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	346.	396.	292.	266.	325.
CO - PPM	1.25	1.37	.92	.69	1.06
CH4 - PPMC	2.00	2.02	1.86	1.75	1.91
NMHC - PPMC	.55	.61	.64	.25	.51
C2H2 - PPMC	.016	.011	.009	.007	.011
C2H4 - PPMC	.027	.013	.012	.010	.016

CABLE AIRPORT

OCTOBER 25, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.542	.598	.488	.173	.450
WIND SPEED - MPH	5.58	4.40	5.63	5.88	5.37
WIND DIR - DEG	168.	202.	245.	257.	218.
TEMP - DEG C	18.1	21.1	22.0	20.1	20.3
RH - %	68.2	60.6	53.9	60.8	60.9
SO_2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O_3 - PPM	.051	.108	.145	.127	.108
NO - PPM	.009	-.008	-.007	.006	.007
NO_X - PPM	.028	.010	.014	.024	.019
HNO_3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH_3 - PPM	-1.000	-1.000	.011	.007	-1.000
PAN - PPM	.014	.024	.020	.016	.019
FREON 11 -PPT	454.	331.	396.	608.	447.
CO - PPM	1.63	1.20	1.74	1.80	1.59
CH_4 - PPMC	2.02	2.06	2.13	2.26	2.12
NMHC - PPMC	.18	.19	.39	.80	.39
C_2H_2 - PPMC	.019	.014	.011	.018	.016
C_2H_4 - PPMC	.019	.014	.017	.016	.017

CABLE AIRPORT

OCTOBER 26, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.569	.699	-.473	.247	.497
WIND SPEED - MPH	5.28	8.25	-15.83	23.40	13.19
WIND DIR - DEG	208.	180.	-131.	81.	150.
TEMP - DEG C	21.9	23.5	-22.1	20.7	22.1
RH - %	37.2	23.3	-22.5	21.7	26.2
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.073	.065	-.055	.045	.059
NO - PPM	.013	.007	≤ .005	≤ .005	.005
NOX - PPM	.029	.012	-.009	.006	.014
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	.008	-.007	.006	.005
PAN - PPM	.002	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	356.	238.	173.	133.	225.
CO - PPM	1.44	.30	.26	.30	.58
CH4 - PPMC	2.02	1.72	1.69	1.58	1.75
NMHC - PPMC	≤ .10	≤ .10	≤ .10	≤ .10	≤ .10
C2H2 - PPMC	.011	.003	≤ .002	≤ .002	.004
C2H4 - PPMC	.012	.003	≤ .002	≤ .002	.004

CABLE AIRPORT

OCTOBER 27, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.581	.697	.558	.238	.519
WIND SPEED - MPH	7.23	6.57	5.15	7.11	6.52
WIND DIR - DEG	206.	216.	226.	187.	209.
TEMP - DEG C	21.5	23.3	24.3	23.1	23.0
RH - %	22.0	21.6	21.5	21.1	21.6
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.043	.055	.072	.059	.057
NO - PPM	.014	.011	.007	.006	.009
NOX - PPM	.024	.031	.020	.025	.025
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	238.	277.	277.	266.	265.
CO - PPM	.90	.60	.60	.60	.68
CH4 - PPMC	1.76	1.77	1.79	1.76	1.77
NMHC - PPMC	.27	.25	≤ .10	.20	.18
C2H2 - PPMC	.017	.003	.012	.006	.010
C2H4 - PPMC	.012	.009	.012	.006	.010

CABLE AIRPORT

OCTOBER 28, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.585	.691	.567	.194	.509
WIND SPEED - MPH	5.42	4.54	5.46	6.80	5.55
WIND DIR - DEG	226.	219.	234.	258.	235.
TEMP - DEG C	22.9	25.2	25.8	22.9	24.2
RH - %	22.6	21.6	21.2	23.1	22.1
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.044	.062	.087	.099	.073
NO - PPM	.016	.012	.009	.006	.011
NOX - PPM	.045	.034	.028	.074	.045
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	≤ .001	≤ .001	.001	.006	.002
FREON 11 -PPT	281.	259.	158.	396.	274.
CO - PPM	1.00	.75	.60	1.29	.91
CH4 - PPMC	1.84	1.80	1.80	1.99	1.86
NMHC - PPMC	≤ .10	.11	.12	.59	.21
C2H2 - PPMC	.015	.008	.010	.015	.012
C2H4 - PPMC	.025	.013	.003	.015	.014

CABLE AIRPORT

OCTOBER 29, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.565	.682	.524	.163	.484
WIND SPEED - MPH	4.25	5.10	8.83	6.22	6.10
WIND DIR - DEG	163.	240.	266.	259.	232.
TEMP - DEG C	20.4	23.2	23.2	20.8	21.9
RH - %	27.7	26.5	31.3	33.4	29.7
SO2 - PPM	≤ .010	≤ .010	≤ .010	.025	≤ .010
O3 - PPM	.021	.080	.102	.046	.062
NO - PPM	.043	≤ .005	≤ .005	≤ .005	.011
NOX - PPM	.110	.038	.045	.065	.065
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	≤ .001	.004	.002	.004	.002
FREON 11 -PPT	364.	245.	313.	266.	297.
CO - PPM	1.80	1.00	1.30	1.20	1.33
CH4 - PPMC	1.92	1.84	2.02	1.91	1.92
NMHC - PPMC	.60	.24	.44	.43	.43
C2H2 - PPMC	.025	.010	.025	.017	.019
C2H4 - PPMC	.026	.012	.020	.018	.019

CABLE AIRPORT

NOVEMBER 1, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.525	.685	.543	.214	.492
WIND SPEED - MPH	3.25	3.03	4.80	3.85	3.73
WIND DIR - DEG	137.	128.	193.	222.	170.
TEMP - DEG C	25.1	29.3	30.2	28.8	28.3
RH - %	27.8	24.0	22.5	22.7	24.3
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.053	.061	.070	.072	.064
NO - PPM	.019	.006	.006	≤ .005	.008
NOX - PPM	.091	.045	.030	.034	.050
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	.005	≤ .005	≤ .005
PAN - PPM	.001	.001	.001	.001	.001
FREON 11 -PPT	547.	299.	230.	223.	325.
CO - PPM	1.75	.90	.75	.90	1.08
CH4 - PPMC	1.69	1.77	1.72	1.79	1.79
NMHC - PPMC	.61	.29	.95	.74	.65
C2H2 - PPMC	.029	.010	.006	.016	.015
C2H4 - PPMC	.029	.013	.010	.020	.018

CABLE AIRPORT

NOVEMBER 2, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.563	.655	.553	.235	.502
WIND SPEED - MPH	3.00	4.68	4.67	3.57	3.98
WIND DIR - DEG	187.	218.	256.	264.	231.
TEMP - DEG C	27.8	31.0	31.9	30.1	30.2
RH - %	26.4	23.4	22.4	22.2	23.6
SO2 - PPM	.015	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.038	.077	.085	.083	.071
NO - PPM	.035	.009	≤ .005	≤ .005	.011
NOX - PPM	.113	.043	.024	.020	.050
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	.005	≤ .005	≤ .005
PAN - PPM	≤ .001	.001	≤ .001	.001	≤ .001
FREON 11 -PPT	331.	299.	148.	198.	244.
CO - PPM	1.00	.92	.50	.48	.73
CH4 - PPMC	1.81	1.72	1.69	1.73	1.74
NMHC - PPMC	.69	.36	.34	.22	.40
C2H2 - PPMC	.028	.008	.006	.004	.012
C2H4 - PPMC	.033	.015	.011	.007	.017

CABLE AIRPORT

NOVEMBER 3, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.566	.670	.522	.201	.490
WIND SPEED - MPH	4.80	6.52	6.00	5.74	5.76
WIND DIR - DEG	201.	229.	248.	276.	239.
TEMP - DEG C	27.8	31.1	32.4	29.5	30.2
RH - %	24.9	24.3	23.7	23.6	24.1
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.034	.062	.082	.087	.066
NO - PPM	.020	.008	≤ .005	≤ .005	.007
NOX - PPM	.059	.043	.029	.038	.042
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	≤ .001	.001	.001	.002	.001
FREON 11 -PPT	238.	248.	234.	234.	239.
CO - PPM	1.00	.75	.66	.80	.80
CH4 - PPMC	1.75	1.74	1.82	1.80	1.78
NMHC - PPMC	.34	.28	.19	.27	.27
C2H2 - PPMC	-1.000	.005	.006	.006	.006
C2H4 - PPMC	-1.000	.010	.005	.011	.009

CABLE AIRPORT

NOVEMBER 4, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.578	.698	.551	.222	.512
WIND SPEED - MPH	4.52	8.85	7.12	5.90	6.60
WIND DIR - DEG	207.	203.	224.	245.	220.
TEMP - DEG C	30.4	32.1	32.9	30.9	31.6
RH - %	26.3	24.2	24.0	23.7	24.6
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.028	.053	.067	.044	.048
NO - PPM	.025	≤ .005	≤ .005	≤ .005	.006
NOX - PPM	.064	.011	.011	.017	.026
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	299.	140.	104.	198.	185.
CO - PPM	1.20	.24	.27	.55	.57
CH4 - PPMC	2.04	1.70	1.70	1.72	1.79
NMHC - PPMC	.74	≤ .10	.16	.28	.30
C2H2 - PPMC	.017	≤ .002	≤ .002	.009	.007
C2H4 - PPMC	.023	.008	.010	.004	.011

CABLE AIRPORT

NOVEMBER 5, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.600	.695	.547	.212	.514
WIND SPEED - MPH	5.52	5.89	4.17	3.00	4.64
WIND DIR - DEG	105.	124.	154.	264.	162.
TEMP - DEG C	27.5	29.8	31.5	29.9	29.6
RH - %	25.9	24.6	24.6	24.3	24.8
SO2 - PPM	.015	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.031	.061	.081	.070	.061
NO - PPM	.020	-1.000	-1.000	-1.000	-1.000
NOX - PPM	.052	.013	.013	.024	.026
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	.009	≤ .005
PAN - PPM	≤ .001	≤ .001	.001	.001	≤ .001
FREON 11 -PPT	281.	281.	216.	133.	228.
CO - PPM	1.25	.35	.50	.64	.69
CH4 - PPMC	1.72	1.67	1.70	1.68	1.69
NMHC - PPMC	.24	.20	≤ .10	.20	.16
C2H2 - PPMC	.005	.004	.005	.007	.005
C2H4 - PPMC	.008	.009	.014	.010	.010

CABLE AIRPORT

NOVEMBER 8, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.589	.686	.554	.186	.504
WIND SPEED - MPH	4.23	7.33	3.97	3.78	4.83
WIND DIR - DEG	139.	238.	179.	233.	197.
TEMP - DEG C	26.1	28.9	30.3	28.3	28.4
RH - %	28.2	26.3	25.2	25.1	26.2
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.040	.053	.072	.066	.057
NO - PPM	.018	.011	≤ .005	≤ .005	.007
NOX - PPM	.063	.041	.014	.026	.036
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	≤ .001	≤ .001	.001	.002	≤ .001
FREON 11 -PPT	479.	349.	198.	216.	311.
CO - PPM	1.30	.60	.30	.78	.75
CH4 - PPMC	1.82	1.75	1.71	1.77	1.76
NMHC - PPMC	.67	.28	.47	.44	.47
C2H2 - PPMC	.012	.008	≤ .002	.008	.007
C2H4 - PPMC	.017	.004	.005	.010	.009

CABLE AIRPORT

NOVEMBER 9, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.527	.647	.514	.180	.467
WIND SPEED - MPH	2.48	4.78	7.94	7.10	5.58
WIND DIR - DEG	156.	224.	248.	271.	225.
TEMP - DEG C	25.2	27.1	26.6	24.1	25.8
RH - %	29.7	30.0	31.1	34.5	31.3
SO2 - PPM	≤ .010	.015	≤ .010	≤ .010	≤ .010
O3 - PPM	.035	.069	.149	.168	.110
NO - PPM	.013	.012	.006	≤ .005	.008
NOX - PPM	.069	.057	.083	.064	.068
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	.001	.002	.008	.018	.008
FREON 11 -PPT	364.	364.	432.	529.	422.
CO - PPM	1.87	1.46	1.35	1.77	1.61
CH4 - PPMC	1.86	1.88	2.07	2.13	1.99
NMHC - PPMC	.42	.41	.56	.81	.55
C2H2 - PPMC	.025	.015	.018	.017	.019
C2H4 - PPMC	.020	.014	.020	.015	.017

CABLE AIRPORT

NOVEMBER 10, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.544	.652	.461	.155	.453
WIND SPEED - MPH	3.22	3.79	7.25	9.83	6.02
WIND DIR - DEG	171.	207.	270.	283.	233.
TEMP - DEG C	20.9	23.9	23.4	20.3	22.1
RH - %	44.2	38.4	40.7	50.2	43.4
SO2 - PPM	.015	≤ .010	≤ .010	.030	.015
O3 - PPM	.077	.151	.194	.202	.156
NO - PPM	.011	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.083	.057	.073	.095	.077
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	.012	.013	.019	.030	.019
FREON 11 -PPT	547.	396.	562.	670.	544.
CO - PPM	2.16	1.53	2.02	2.45	2.04
CH4 - PPMC	2.10	2.04	2.31	2.38	2.21
NMHC - PPMC	.33	.59	1.61	1.56	1.15
C2H2 - PPMC	.035	.023	.042	.035	.034
C2H4 - PPMC	.030	.025	.027	.050	.033

CABLE AIRPORT

NOVEMBER 11, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.220	.357	.180	.106	.216
WIND SPEED - MPH	2.38	4.03	4.35	5.48	4.06
WIND DIR - DEG	218.	164.	*****	225.	*****
TEMP - DEG C	15.5	17.3	17.4	16.4	16.6
RH - %	77.4	69.9	58.8	64.2	67.6
SO_2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O_3 - PPM	.045	.069	.056	.029	.050
NO - PPM	.009	≤ .005	≤ .005	.006	≤ .005
NO_X - PPM	.058	.026	.019	.033	.034
HNO_3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH_3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	.008	.004	.001	≤ .001	.003
FREON 11 -PPT	454.	299.	198.	529.	370.
CO - PPM	2.20	.95	.55	1.10	1.20
CH_4 - PPMC	2.17	1.90	1.76	1.80	1.91
NMHC - PPMC	.77	.43	.18	.30	.42
C_2H_2 - PPMC	.023	.016	.010	.015	.016
C_2H_4 - PPMC	.027	.018	.019	.018	.021

CABLE AIRPORT

NOVEMBER 12, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.193	.557	.178	.028	.239
WIND SPEED - MPH	2.22	3.05	5.23	3.22	3.43
WIND DIR - DEG	305.	243.	199.	98.	211.
TEMP - DEG C	13.0	16.5	14.8	11.7	14.0
RH - %	94.5	69.5	67.7	91.7	80.9
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.016	.045	.038	.013	.028
NO - PPM	.019	≤ .005	.009	.011	.010
NOX - PPM	.048	.021	.042	.048	.040
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	≤ .001	≤ .001	.001	.001	≤ .001
FREON 11 -PPT	223.	133.	216.	261.	213.
CO - PPM	.90	.57	1.20	1.10	.94
CH4 - PPMC	2.00	1.80	1.86	1.89	1.89
NMHC - PPMC	.48	.18	.42	.53	.40
C2H2 - PPMC	.019	.008	.015	.012	.014
C2H4 - PPMC	.035	.018	.028	.020	.025

CABLE AIRPORT

NOVEMBER 15, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
G IRRAD - LANGLEY/MN	.559	.652	.510	.180	.476
WIND SPEED - MPH	5.92	7.48	6.80	3.71	5.98
WIND DIR - DEG	257.	282.	302.	264.	276.
TEMP - DEG C	18.5	20.6	21.8	20.6	20.4
RH - %	62.9	51.9	46.8	47.5	52.3
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.033	.053	.068	.068	.055
NO - PPM	.020	.024	.018	≤ .005	.016
NOX - PPM	.040	.052	.045	.063	.050
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	≤ .001	.002	.004	.005	.003
FREON 11 -PPT	166.	198.	263.	281.	227.
CO - PPM	.92	.98	.87	1.64	1.10
CH4 - PPMC	2.14	2.20	1.86	1.92	2.03
NMHC - PPMC	.58	.48	.42	.78	.57
C2H2 - PPMC	.035	.037	.018	.030	.030
C2H4 - PPMC	.042	.033	.020	.023	.030

CABLE AIRFORT

1976 FIELD PROGRAM AVERAGES

	9 - 11	11 - 13	13 - 15	15 - 17	GRAND AVERAGE
G IRRAD - LANGLEY/MN	.475	.602	.462	.173	.428
WIND SPEED - MPH	4.48	5.53	6.78	6.84	5.91
WIND DIR - DEG	197.	214.	*****	235.	*****
TEMP - DEG C	21.9	24.7	25.1	23.1	23.7
RH - %	49.0	41.1	39.0	41.7	42.7
SO2 - PPM	≤ .010	≤ .010	≤ .010	≤ .010	≤ .010
O3 - PPM	.048	.085	.106	.099	.085
NO - PPM	.017	.006	≤ .005	≤ .005	.008
NOX - PPM	.059	.036	.035	.040	.043
HNO3 - PPM	≤ .006	≤ .006	≤ .006	≤ .006	≤ .006
NH3 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
PAN - PPM	.004	.005	.006	.008	.006
FREON 11 -PPT	355.	285.	300.	327.	317.
CO - PPM	1.65	1.18	1.05	1.34	1.31
CH4 - PPMC	2.02	1.93	1.93	1.94	1.95
NMHC - PPMC	.56	.39	.43	.54	.48
C2H2 - PPMC	.021	.012	.013	.015	.015
C2H4 - PPMC	.025	.014	.014	.017	.018

RUBIDOUX

OCTOBER 15, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.010	.010	.015	.025	.015
O3 - PPM	.065	.115	.135	.160	.119
NO - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.055	.035	.030	.040	.040
PAN - PPM	.010	.004	.004	.006	.006
FREON 11 -PPT	637.	-689.	-740.	792.	715.
CO - PPM	1.91	1.48	1.22	1.38	1.50
CH4 - PPMC	2.49	2.30	2.38	2.38	2.39
NMHC - PPMC	1.01	-1.00	-1.00	-1.00	-1.00
C2H2 - PPMC	.013	≤ .002	.013	.013	.010

RUBIDOUX

OCTOBER 18, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	-.010	.010	.020	.020	.015
O3 - PPM	.075	.100	.115	.095	.096
NO - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.030	.030	.020	.030	.028
PAN - PPM	.008	.002	.002	≤ .001	.003
CO - PPM	1.30	1.10	1.05	.97	1.11
CH4 - PPMC	2.18	2.15	2.12	2.16	2.15
NMHC - PPMC	1.17	.80	1.30	-1.00	1.09
C2H2 - PPMC	.006	≤ .002	.010	.050	.017

RUBIDOUX

OCTOBER 19, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.010	.020	.020	.030	.020
O3 - PPM	.035	.090	.140	.155	.105
NO - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.125	.085	.040	.065	.079
PAN - PPM	≤ .001	.002	.016	.016	.009
FREON 11 -PPT	-1.	-1.	742.	1696.	-1.
CO - PPM	2.20	1.85	1.30	2.10	1.86
CH4 - PPMC	2.20	2.17	2.19	2.42	2.25
NMHC - PPMC	1.17	1.09	.77	1.19	1.06
C2H2 - PPMC	.020	.015	.012	.026	.018
C2H4 - PPMC	.048	-1.000	.015	.053	.039

RUBIDOUX

OCTOBER 20, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	.020	.015	.010	.011
O3 - PPM	.025	.070	.055	.020	.043
NO - PPM	.025	≤ .005	≤ .005	≤ .005	.006
NOX - PPM	.180	-.105	-.075	.030	.098
PAN - PPM	≤ .001	.006	.004	≤ .001	.003
CO - PPM	4.10	3.06	2.40	.65	2.55
CH4 - PPMC	2.85	2.60	2.25	1.76	2.37
NMHC - PPMC	1.80	1.44	.98	.29	1.13
C2H2 - PPMC	.045	.030	.017	.007	.025
C2H4 - PPMC	.070	.075	.020	.048	.053

RUBIDOUX

OCTOBER 21, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.010	.020	.020	.020	.018
O3 - PPM	.055	.095	.100	.100	.088
NO - PPM	≤ .005	≤ .005	≤ .005	.010	≤ .005
NOX - PPM	.070	.040	.045	.055	.053
PAN - PPM	.002	.004	.004	.006	.004
FREON 11 -PPT	-1.	742.	792.	860.	798.
CO - PPM	1.90	1.20	1.14	1.20	1.36
CH4 - PPMC	2.26	2.10	1.99	1.99	2.09
NMHC - PPMC	1.24	.70	.61	.66	.80
C2H2 - PPMC	.005	.003	.009	.012	.007

RUBIDOUX

OCTOBER 22, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	.010	.010	≤ .005
O3 - PPM	.045	.065	.055	.045	.053
NO - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.045	.040	.055	.045	.046
PAN - PPM	.002	.002	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	346.	558.	662.	1058.	656.
CO - PPM	1.00	1.02	.96	.76	.94
CH4 - PPMC	2.01	2.11	1.90	1.90	1.96
NMHC - PPMC	1.35	.79	.98	.75	.97
C2H2 - PPMC	.005	.011	.009	.010	.009

RUBIDOUX

OCTOBER 25, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	-.010	.015	.025	.013
O3 - PPM	-.040	.090	.100	.135	.091
NO - PPM	-.060	-.010	≤ .005	≤ .005	.018
NOX - PPM	.085	-.035	.025	.050	.049
PAN - PPM	≤ .001	.004	.006	.008	.005
FREON 11 -PPT	396.	371.	396.	796.	490.
CO - PPM	1.62	.96	.80	1.40	1.20
CH4 - PPMC	2.09	2.00	2.01	2.13	2.06
NMHC - PPMC	.76	.38	.69	1.34	.79
C2H2 - PPMC	.020	.018	.005	.014	.014
C2H4 - PPMC	.020	.009	.006	.012	.012

RUBIDOUX

OCTOBER 26, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.030	.030	.030	.030	.030
NO - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.020	.020	-.020	-.025	.021
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	346.	346.	212.	196.	275.
CO - PPM	.93	.46	.55	.82	.69
CH4 - PPMC	1.94	1.62	1.54	1.57	1.67
NMHC - PPMC	.76	.40	.37	.37	.48
C2H2 - PPMC	.006	.009	.006	.004	.006

RUBIDOUX

OCTOBER 27, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.030	.030	.030	.030	.030
NO - PPM	-.010	-.010	.010	.010	.010
NOX - PPM	-.030	.030	.035	.045	.035
PAN - PPM	≤ .001	≤ .001	-1.000	-1.000	-1.000
FREON 11 -PPT	238.	238.	-1.	-1.	-1.
CO - PPM	.40	.50	-1.00	-1.00	-1.00
CH4 - PPMC	1.67	1.80	-1.00	-1.00	-1.00
NMHC - PPMC	.43	.22	-1.00	-1.00	-1.00
C2H2 - PPMC	≤ .002	.003	-1.000	-1.000	-1.000

RUBIDOUX

OCTOBER 28, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.030	.030	.030	.020	.028
NOX - PPM	.035	.030	.040	.110	.054
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	166.	133.	133.	216.	162.
CO - PPM	.65	.40	.50	.67	.56
CH4 - PPMC	1.75	1.73	1.75	1.82	1.76
NMHC - PPMC	.51	.21	.11	.28	.28
C2H2 - PPMC	.015	≤ .002	≤ .002	.004	.005

RUBIDOUX

OCTOBER 29, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	.010	.015	.020	.011
O3 - PPM	.020	.080	.080	.065	.061
NO - PPM	-.050	-.010	≤ .005	≤ .005	.015
NOX - PPM	-.105	-.045	.035	.050	.059
PAN - PPM	.002	≤ .001	.004	.004	.002
FREON 11 -PPT	248.	396.	432.	299.	344.
CO - PPM	.70	1.45	.83	.63	.90
CH4 - PPMC	1.92	1.93	1.92	1.89	1.92
NMHC - PPMC	.45	.86	.48	.16	.49
C2H2 - PPMC	.011	.022	.008	.010	.013
C2H4 - PPMC	.045	.030	.026	.010	.028

RUBIDOUX

NOVEMBER 1, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.015	.035	.045	.030	.031
NO - PPM	-.045	-.015	≤ .005	≤ .005	.015
NOX - PPM	-.130	-.050	.025	.035	.060
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	529.	256.	184.	198.	292.
CO - PPM	2.20	.50	.63	.80	1.03
CH4 - PPMC	1.84	1.68	1.72	1.67	1.73
NMHC - PPMC	.76	.22	.23	.35	.39
C2H2 - PPMC	.035	.005	.012	.011	.016
C2H4 - PPMC	.039	.020	.030	.050	.035

RUBIDOUX

NOVEMBER 2, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.010	.035	-.035	.020	.025
NO - PPM	.055	≤ .005	≤ .005	≤ .005	.014
NOX - PPM	.120	.035	.020	.030	.051
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	266.	198.	173.	144.	195.
CO - PPM	1.73	.68	.48	.60	.87
CH4 - PPMC	1.89	1.70	1.72	1.70	1.75
NMHC - PPMC	.76	.40	.29	.30	.44
C2H2 - PPMC	.026	.004	.008	.009	.012
C2H4 - PPMC	.042	-1.000	.020	.035	.032

RUBIDOUX

NOVEMBER 3, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.020	.045	.035	.020	.030
NO - PPM	.040	-.010	≤ .005	≤ .005	.013
NOX - PPM	.110	.050	-.030	-.040	.058
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	392.	230.	-214.	198.	259.
CO - PPM	1.90	.84	-.72	.60	1.02
CH4 - PPMC	1.96	1.75	-1.73	1.70	1.78
NMHC - PPMC	1.25	.47	-.24	≤ .10	.49
C2H2 - PPMC	.026	.010	-.007	.003	.011

RUBIDOUX

NOVEMBER 4, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.015	.035	.030	.020	.025
NO - PPM	-.035	-.015	≤ .005	≤ .005	.013
NOX - PPM	-.075	-.040	.020	.025	.040
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	230.	198.	144.	266.	210.
CO - PPM	1.10	.42	.62	.72	.72
CH4 - PPMC	1.74	1.68	1.68	1.70	1.70
NMHC - PPMC	.56	.32	.33	.83	.51
C2H2 - PPMC	.014	.003	.003	.009	.007

RUBIDOUX

NOVEMBER 5, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.015	.035	.045	.035	.033
NO - PPM	-.060	-.020	≤ .005	.015	.024
NOX - PPM	-.105	-.045	.020	.045	.054
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	230.	194.	115.	306.	212.
CO - PPM	1.63	.74	.40	2.50	1.32
CH4 - PPMC	1.86	1.69	1.67	1.75	1.74
NMHC - PPMC	.98	.39	.13	1.39	.72
C2H2 - PPMC	.020	.010	.005	.028	.016

RUBIDOUX

NOVEMBER 8, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	.010	≤ .005
O3 - PPM	.015	.045	.050	.060	.043
NO - PPM	.075	≤ .005	≤ .005	≤ .005	.019
NOX - PPM	.145	.035	.010	.010	.050
PAN - PPM	≤ .001	≤ .001	≤ .001	.001	≤ .001
FREON 11 -PPT	446.	266.	184.	331.	307.
CO - PPM	1.80	.58	.20	.46	.76
CH4 - PPMC	1.92	1.74	1.66	1.84	1.79
NMHC - PPMC	-1.00	.51	.42	.96	.63
C2H2 - PPMC	.050	.007	.005	.005	.017

RUBIDOUX

NOVEMBER 9, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO_2 - PPM	≤ .005	.010	.020	.030	.015
O_3 - PPM	.010	.060	.125	.150	.086
NO - PPM	.040	≤ .005	≤ .005	≤ .005	.010
NOX - PPM	.105	.040	-.015	.025	.046
PAN - PPM	≤ .001	.001	.006	.011	.005
FREON 11 -PPT	450.	313.	515.	763.	510.
CO - PPM	2.08	.88	.88	1.35	1.30
CH_4 - PPMC	2.32	2.01	2.15	2.06	2.14
NMHC - PPMC	1.25	.59	.65	.90	.85
C_2H_2 - PPMC	.034	.007	.016	.022	.020

RUBIDOUX

NOVEMBER 10, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.015	.025	.030	.040	.028
O3 - PPM	.060	.115	.145	.135	.114
NO - PPM	.030	≤ .005	≤ .005	≤ .005	.008
NOX - PPM	.100	.025	.010	.035	.043
PAN - PPM	.004	.008	.008	.017	.009
FREON 11 -PPT	364.	479.	364.	893.	525.
CO - PPM	1.38	1.04	.80	1.46	1.17
CH4 - PPMC	2.10	2.00	2.04	2.30	2.11
NMHC - PPMC	.69	.54	.46	.86	.64
C2H2 - PPMC	.021	.012	.014	.019	.017
C2H4 - PPMC	.025	.033	.020	.045	.031

RUBIDOUX

NOVEMBER 11, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	.010	.010	.010	.010	.010
O3 - PPM	.040	.060	.060	.040	.050
NO - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	.050	.010	.015	.010	.021
PAN - PPM	.004	.006	.004	.002	.004
FREON 11 -PPT	432.	414.	396.	425.	417.
CO - PPM	1.65	.80	.65	.45	.89
CH4 - PPMC	2.15	1.90	1.80	1.90	1.94
NMHC - PPMC	.98	.38	.30	.18	.46
C2H2 - PPMC	.025	.010	.005	.010	.013
C2H4 - PPMC	.028	.030	.020	.026	.026

RUBIDOUX

NOVEMBER 12, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.015	.025	.010	.010	.015
NO - PPM	-.010	-.010	-.010	.015	.011
NOX - PPM	-.030	-.040	-.050	.060	.045
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	245.	400.	349.	464.	365..
CO - PPM	.45	.65	1.15	1.60	.96
CH4 - PPMC	1.93	1.87	1.88	1.85	1.88
NMHC - PPMC	.24	.42	.51	.70	.47
C2H2 - PPMC	.011	.010	.018	.030	.017
C2H4 - PPMC	.011	.020	.025	.030	.022

RUBIDOUX

NOVEMBER 15, 1976

	9 - 11	11 - 13	13 - 15	15 - 17	DAILY AVERAGE
SO2 - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
O3 - PPM	.030	.030	.030	.025	.029
NO - PPM	≤ .005	≤ .005	≤ .005	≤ .005	≤ .005
NOX - PPM	-.015	.020	.020	.020	.019
PAN - PPM	≤ .001	≤ .001	≤ .001	≤ .001	≤ .001
FREON 11 -PPT	158.	166.	133.	191.	162.
CO - PPM	.40	.40	.45	.45	.43
CH4 - PPMC	1.70	1.70	1.63	1.68	1.68
NMHC - PPMC	.23	.12	.18	.13	.17
C2H2 - PPMC	.004	.005	.010	.005	.006
C2H4 - PPMC	.008	.012	.020	.025	.016

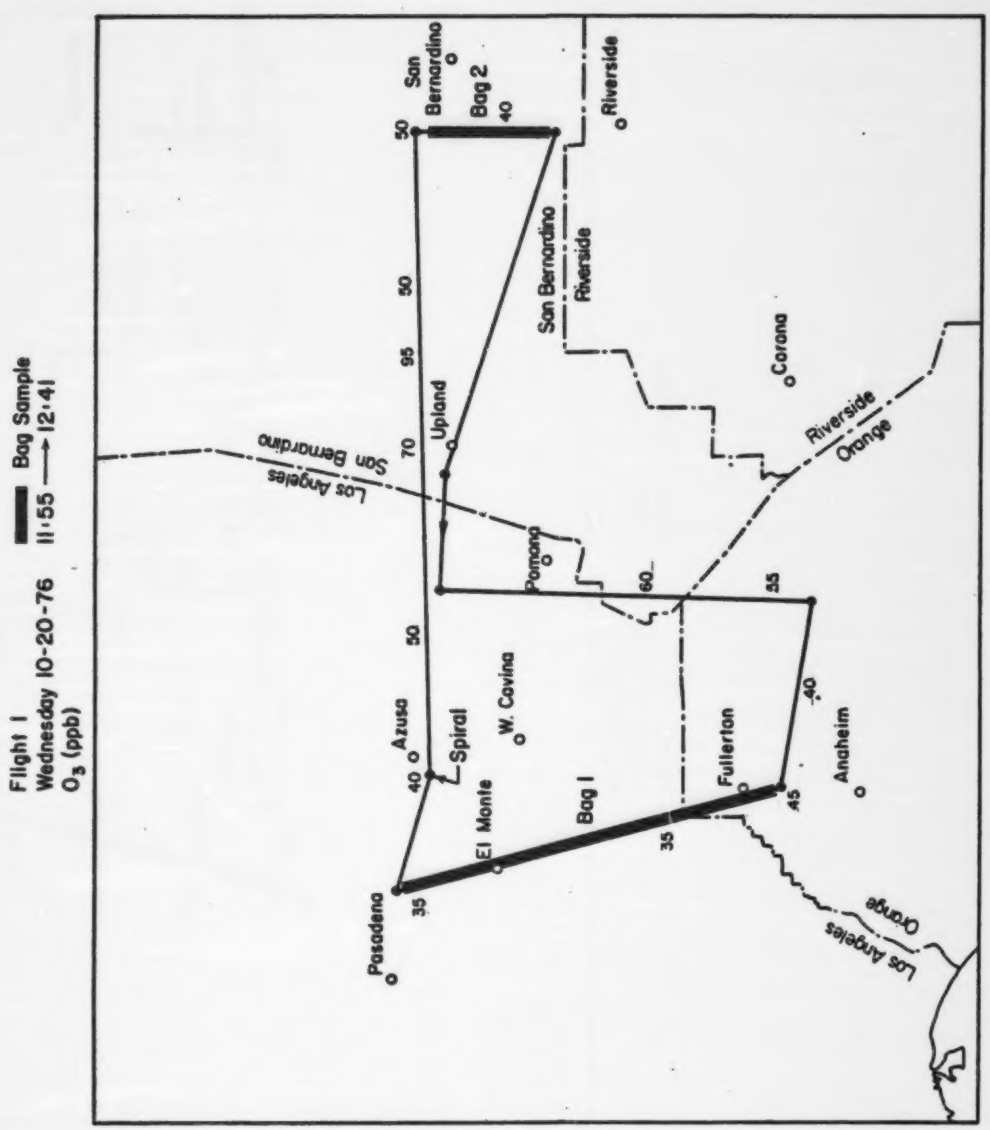
RUBIDOUX

1976 FIELD PROGRAM AVERAGES

	9 - 11	11 - 13	13 - 15	15 - 17	GRAND AVERAGE
SO2 - PPM	≤ .005	.007	.009	.011	.007
O3 - PPM	.032	.060	.067	.064	.056
NO - PPM	.025	≤ .005	≤ .005	≤ .005	.008
NOX - PPM	.080	.040	.030	.040	.048
PAN - PPM	.001	.002	.003	.003	.002
FREON 11 -PPT	340.	347.	362.	531.	395.
CO - PPM	1.50	.95	.84	1.03	1.08
CH4 - PPMC	2.04	1.92	1.89	1.91	1.94
NMHC - PPMC	.87	.54	.50	.61	.63
C2H2 - PPMC	.019	.009	.009	.014	.013
C2H4 - PPMC	.034	.029	.020	.033	.029

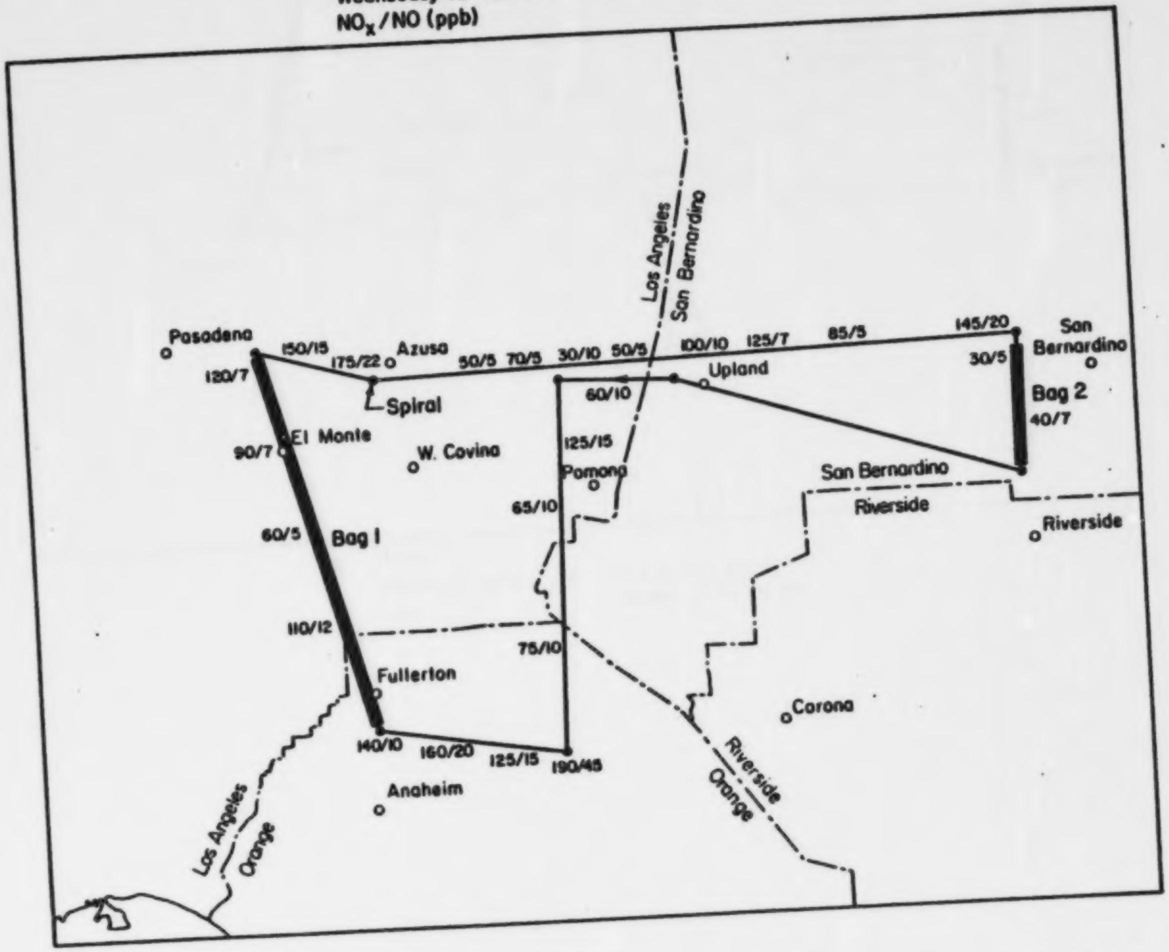
APPENDIX B

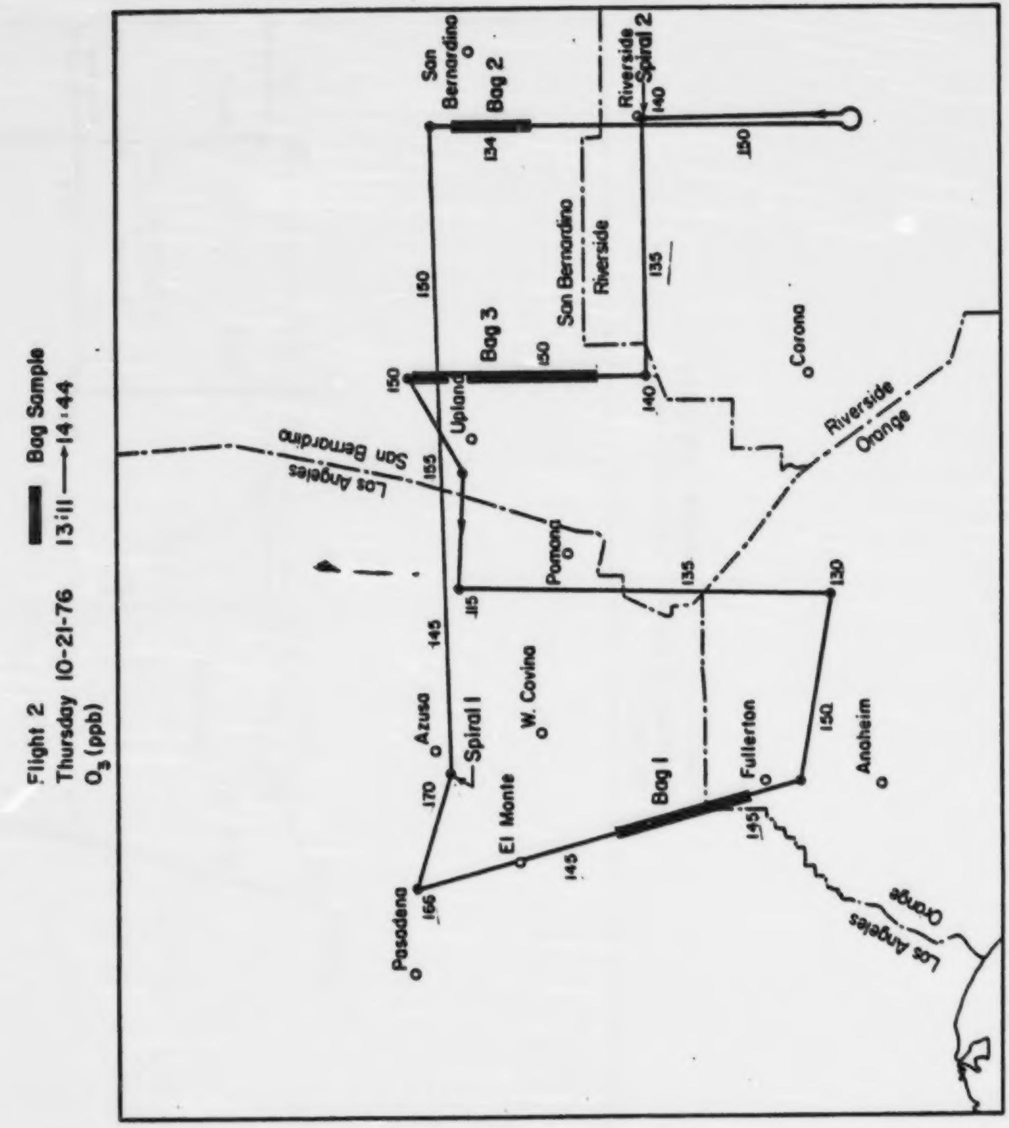
FLIGHT MAPS AND VERTICAL PROFILES FROM THE LOS ANGELES FIELD PROGRAM


Bag Sample
11:55 ⟶ 12:41
Pasadena
35
El Monte
Bag 1
35
Fullerton
45
Anaheim
40
Azusa
40
Spiral
W. Covina
50
Pomona
60
55
70
Upland
95
50
50
San Bernardino
Bag 2
40
Riverside
San Bernardino
Riverside
Corona
Los Angeles
San Bernardino
Riverside
Orange
Los Angeles
Orange

Flight 1
Wednesday 10-20-76
O_3 (ppb)

Flight 1
Wednesday 10-20-76
NO_x/NO (ppb)


Bag Sample
11:55 → 12:41
Pasadena
120/7
150/15
175/22
Azusa
Spiral
50/5
70/5
30/10
50/5
100/10
125/7
85/5
145/20
San Bernardino
30/5
Bag 2
40/7
El Monte
90/7
W. Covina
Upland
60/10
125/15
Pomona
65/10
Bag 1
60/5
110/12
75/10
Fullerton
140/10
160/20
125/15
190/45
Anaheim
Corona
Riverside
Los Angeles
San Bernardino
San Bernardino
Riverside
Riverside
Orange
Los Angeles
Orange

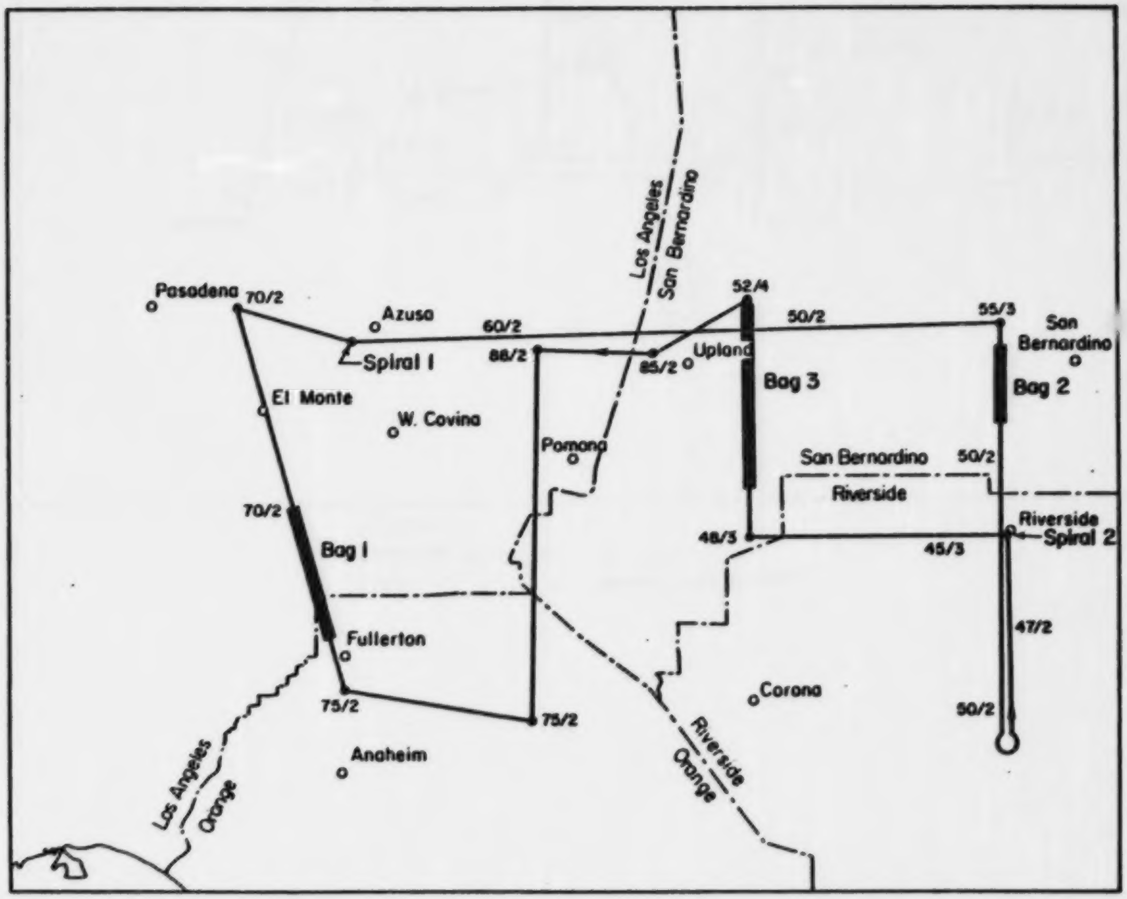


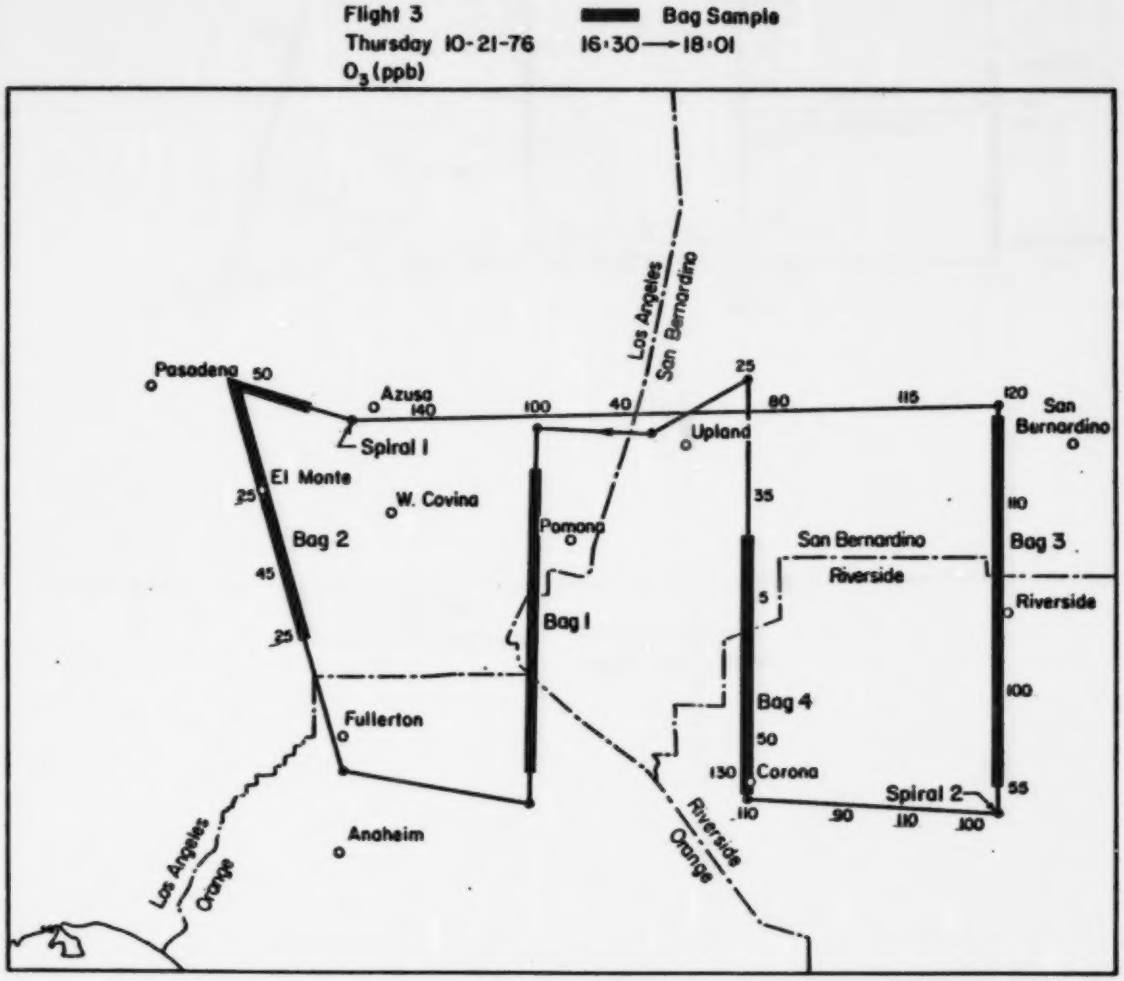
Flight 2
Thursday 10-21-76
O_3 (ppb)

▮ Bag Sample
13:11 ⟶ 14:44
San Bernardino
Bag 2
134
Riverside
Spiral 2
140
150
San Bernardino
Riverside
135
150
Bag 3
150
150
Upland
140
Corona
Los Angeles
San Bernardino
155
Riverside
Orange
Pomona
135
115
130
145
W. Covina
Azusa
Spiral 1
170
Fullerton
150
Anaheim
Bag 1
El Monte
145
145
Pasadena
166
Los Angeles
Orange

Flight 2
Thursday 10-21-76
NO_x/NO

▬ Bag Sample
13:11 ⟶ 14:44


Pasadena
70/2
Azusa
Spiral 1
60/2
88/2
85/2
Upland
52/4
50/2
55/3
San Bernardino
Bag 2
Bag 3
Los Angeles
San Bernardino
El Monte
W. Covina
Pomona
San Bernardino
Riverside
50/2
70/2
Bag 1
48/3
45/3
Riverside
Spiral 2
Fullerton
47/2
Corona
75/2
75/2
50/2
Anaheim
Los Angeles
Orange
Riverside
Orange

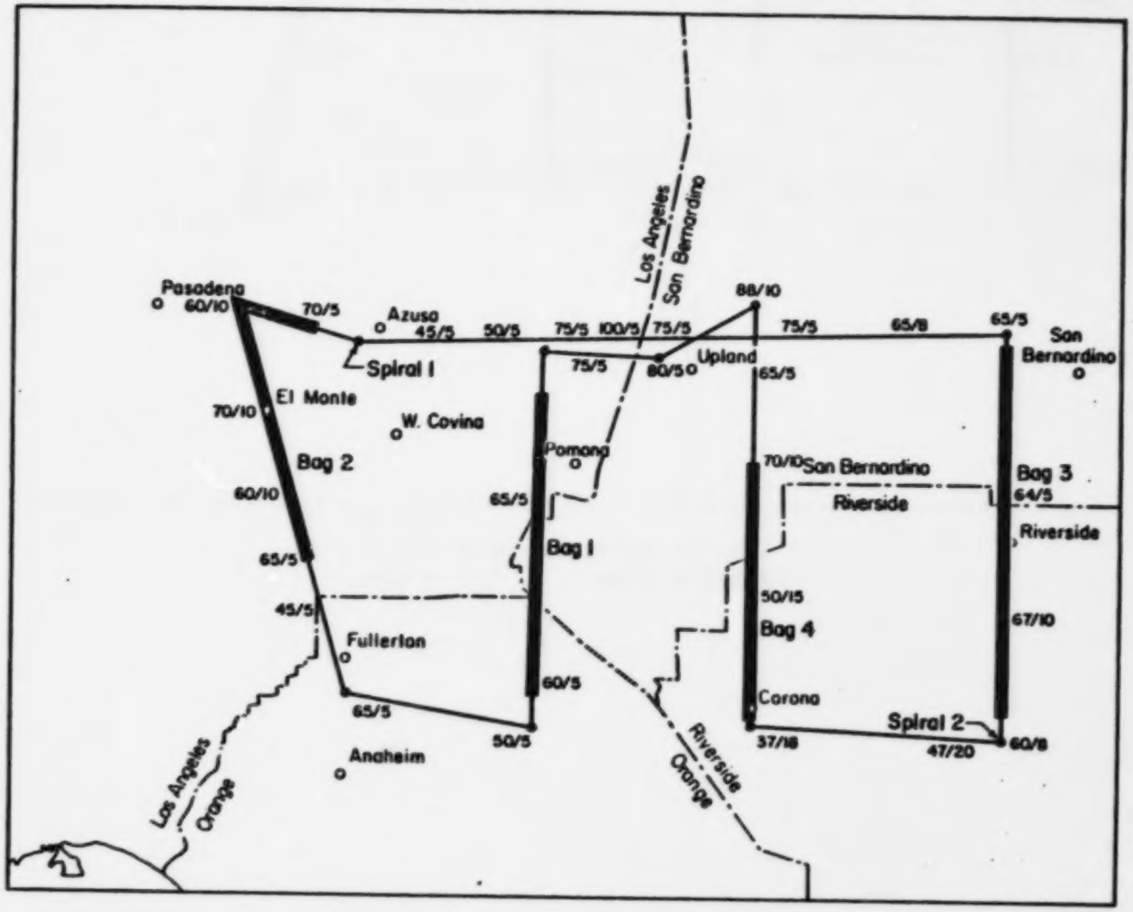


Flight 3
Thursday 10-21-76
O_3 (ppb)

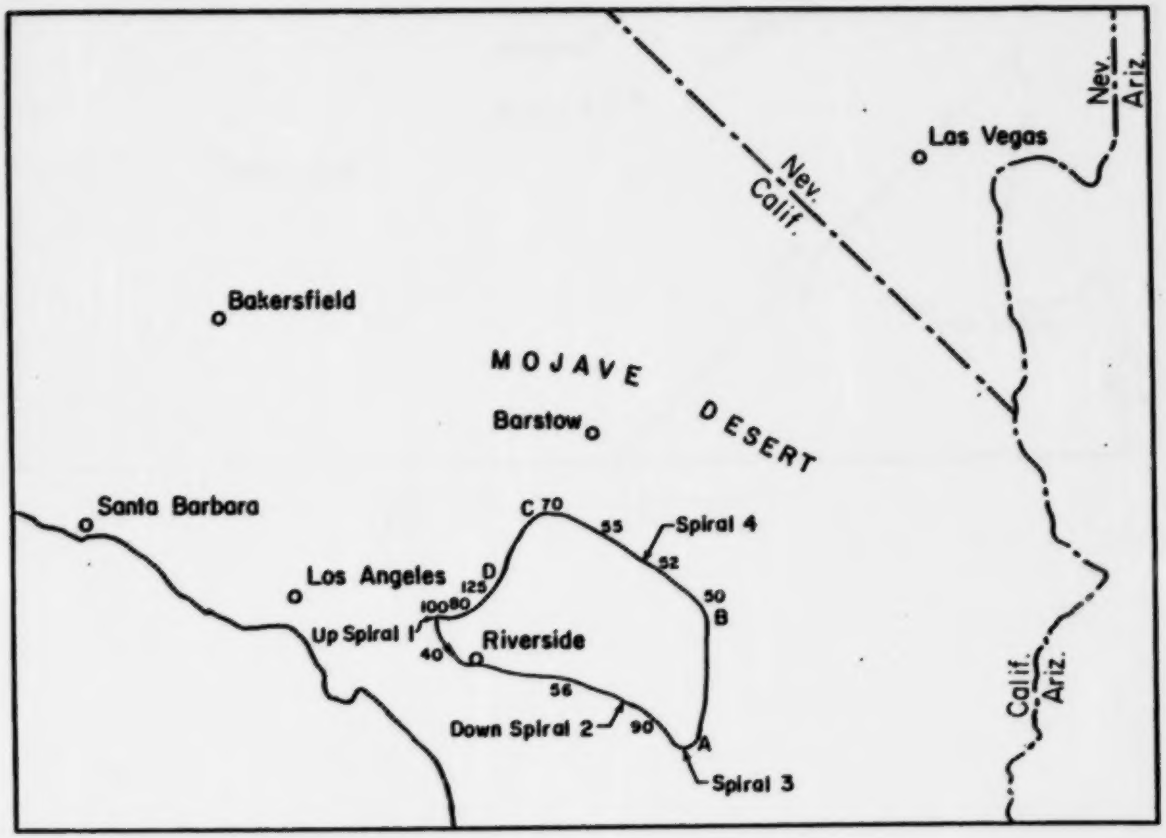
Bag Sample
16:30 → 18:01
Pasadena
50
Azusa
140
Spiral 1
100
40
Upland
25
80
115
120
San Bernardino
El Monte
25
W. Covina
Bag 2
45
25
Pomona
Bag 1
Fullerton
Anaheim
Los Angeles
San Bernardino
Los Angeles
Orange
Riverside
Orange
35
5
Bag 4
50
130
Corona
110
90
110
100
Spiral 2
55
San Bernardino
Riverside
110
Bag 3
Riverside
100

Flight 3
Thursday 10-21-76
NO_x/NO(ppb)

▬ Bag Sample
16:30 → 18:01


Pasadena
60/10
70/5
Azusa
45/5
50/5
75/5
100/5
75/5
88/10
75/5
65/8
65/5
San Bernardino
Spiral 1
75/5
80/5
Upland
65/5
El Monte
70/10
W. Covina
Bag 2
60/10
65/5
45/5
Pomona
65/5
Bag 1
60/5
50/5
Fullerton
65/5
Anaheim
Los Angeles
San Bernardino
70/10
San Bernardino
Riverside
50/15
Bag 4
Corona
37/18
47/20
Spiral 2
60/8
Bag 3
64/5
Riverside
67/10
Riverside
Orange
Los Angeles
Orange

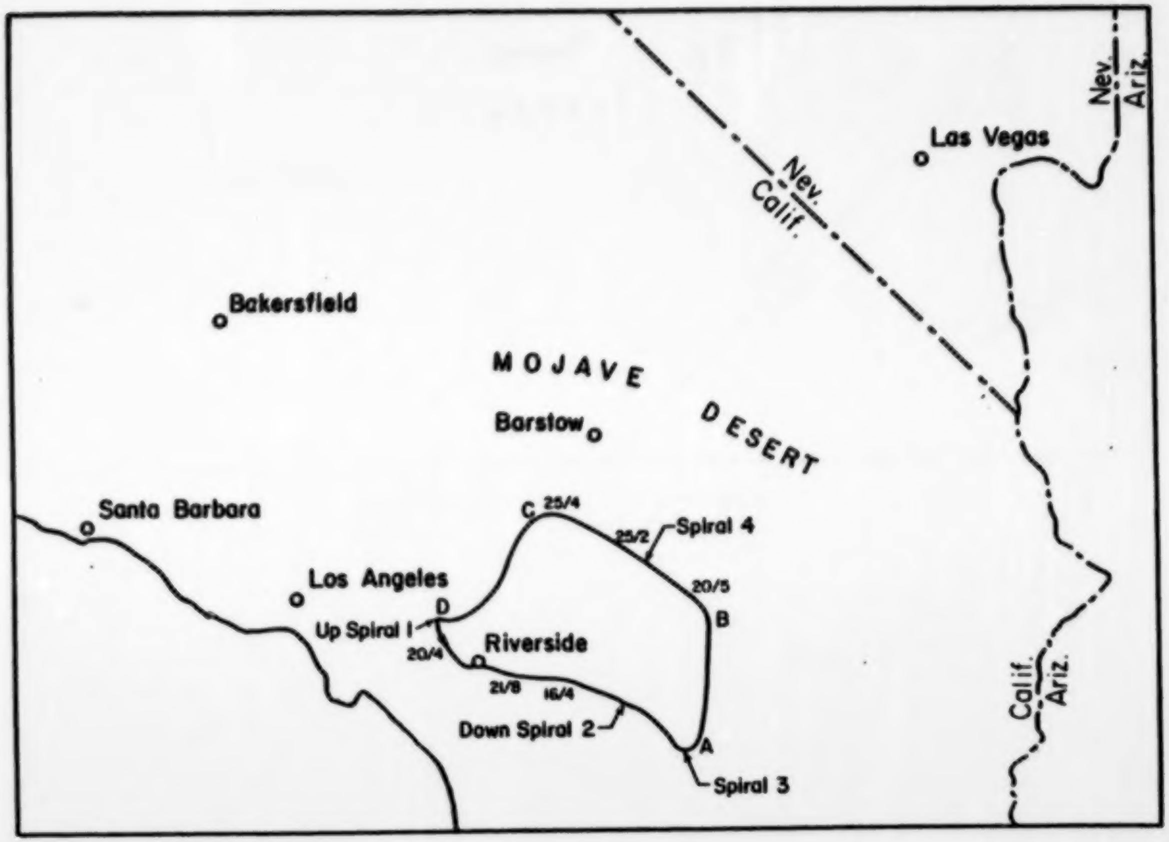
Flight 4 Friday 10-22-76 O_3 (ppb) 12:14 → 14:27


Nev. Ariz.
Las Vegas
Nev. Calif.
Bakersfield
MOJAVE DESERT
Barstow
Santa Barbara
Los Angeles
C 70
55
Spiral 4
52
50
B
D
125
100
80
Up Spiral 1
Riverside
40
56
Down Spiral 2
90
A
Spiral 3
Calif. Ariz.

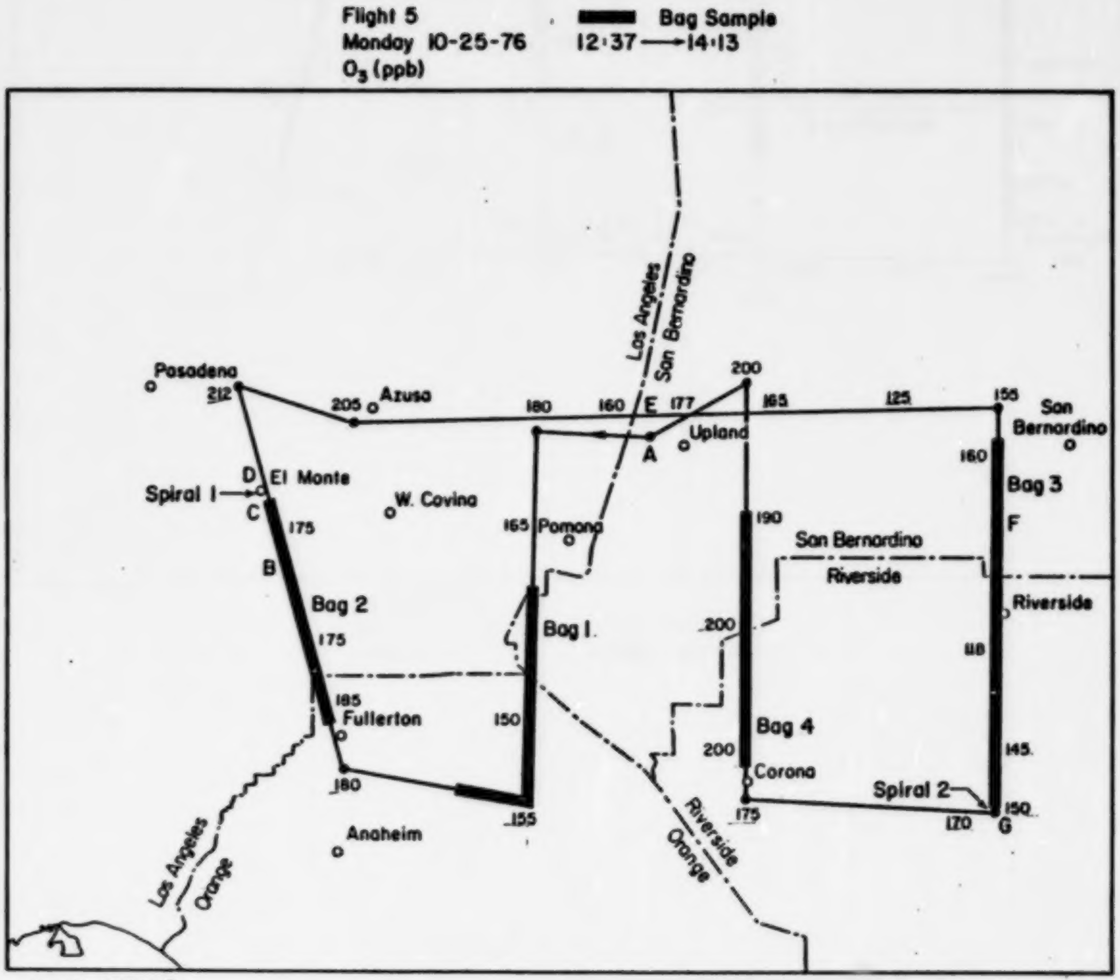
A → B, C → D } Rain - stopped sampling

Flight 4 Friday 10-22-76

NO_x/NO (ppb) 12:14 ⟶ 14:27

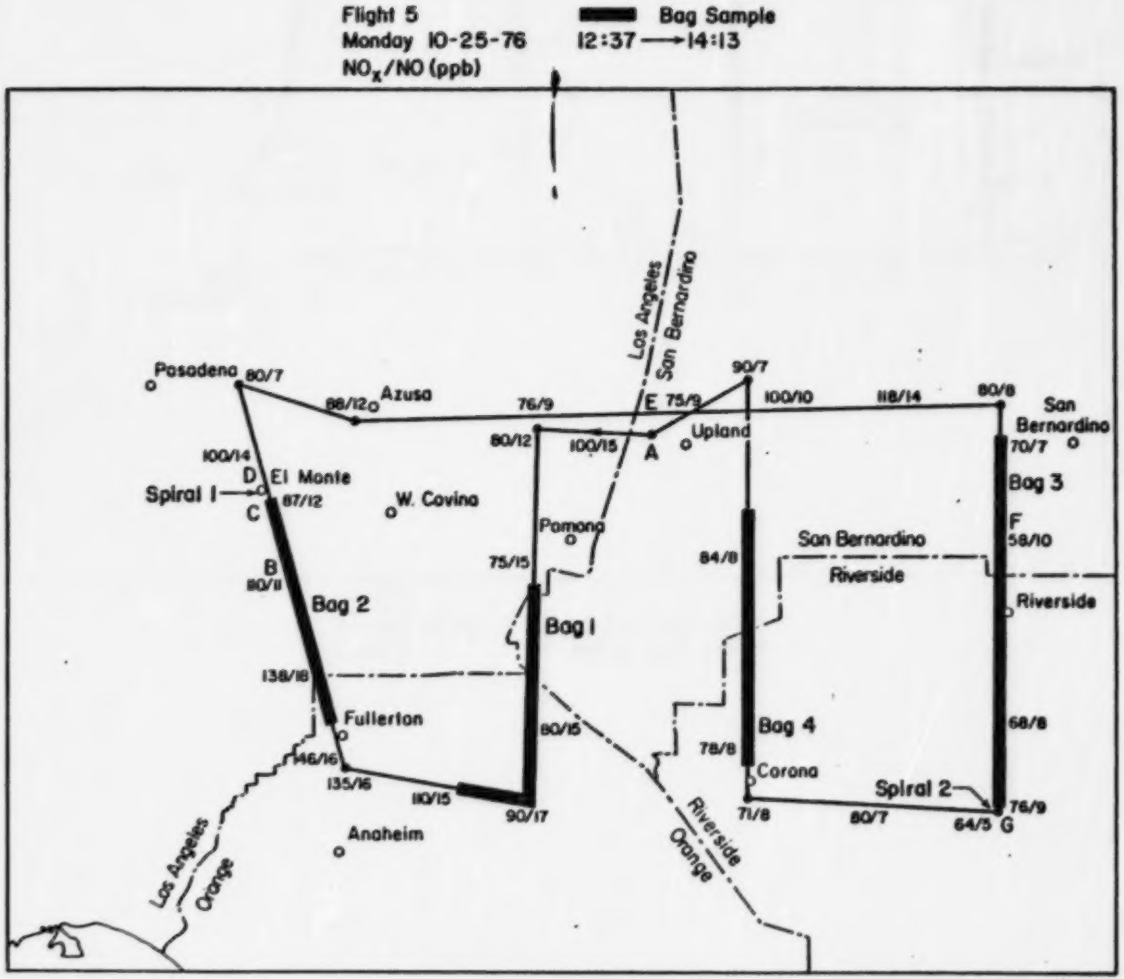

Las Vegas
Nev.
Ariz.
Nev.
Calif.
MOJAVE DESERT
Bakersfield
Barstow
Santa Barbara
Los Angeles
Riverside
C
25/4
25/2
Spiral 4
20/5
B
D
Up Spiral 1
20/4
21/8
16/4
Down Spiral 2
A
Spiral 3
Calif.
Ariz.

A—B } Rain - stopped sampling
C—D }


Flight 5
Monday 10-25-76
O_3 (ppb)
▬ Bag Sample
12:37 → 14:13
Pasadena
212
205
Azusa
180
160
E
177
200
165
125
155
San Bernardino
A
Upland
D
El Monte
Spiral 1
C
175
W. Covina
165
Pomona
190
San Bernardino
Riverside
160
Bag 3
F
Riverside
B
Bag 2
175
Bag 1.
200
118
185
Fullerton
150
Bag 4
200
Corona
145.
180
155
175
Spiral 2
150
170
G
Anaheim
Los Angeles
San Bernardino
Riverside
Orange
Los Angeles
Orange

A → B 2200]

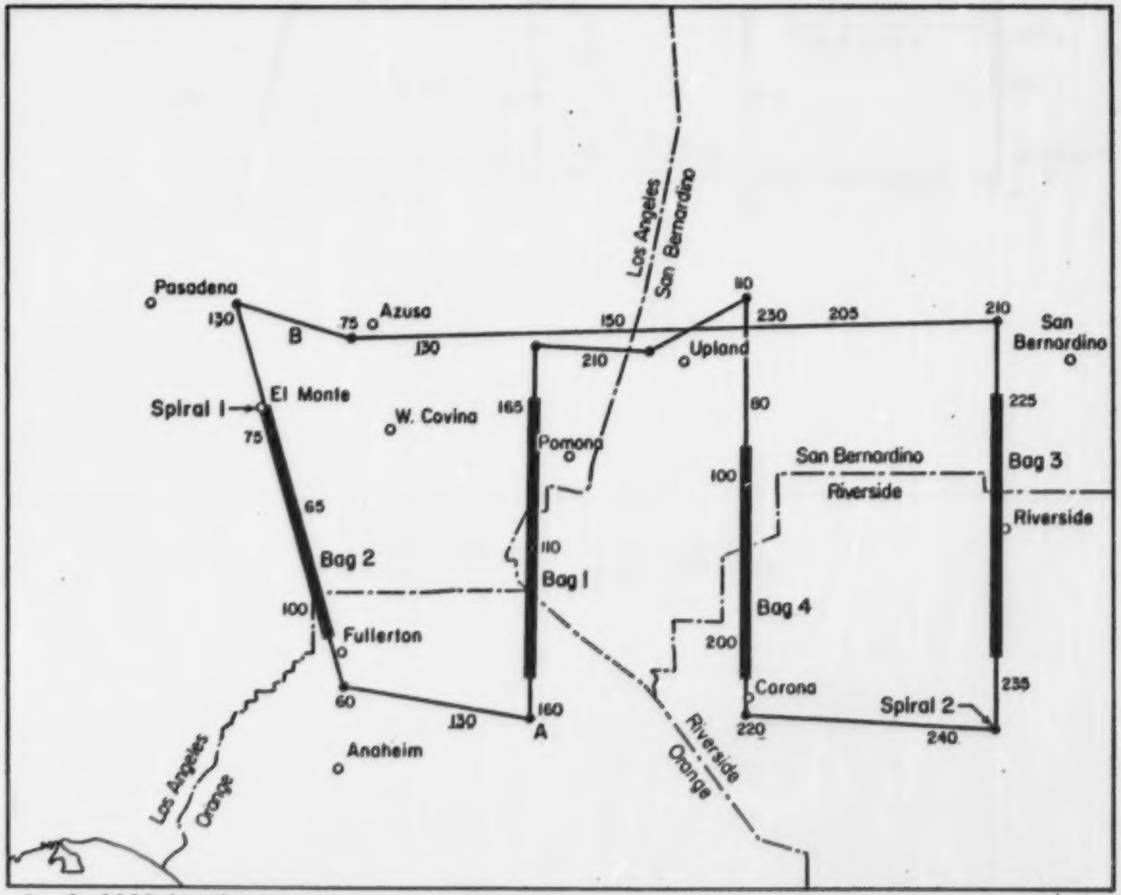
Flight 5
Monday 10-25-76
NO_x/NO (ppb)


Bag Sample
12:37 → 14:13
Pasadena
80/7
88/12
Azusa
76/9
E
75/9
90/7
100/10
118/14
80/8
San Bernardino
Los Angeles
San Bernardino
80/12
100/15
A
Upland
70/7
Bag 3
100/14
D
El Monte
Spiral I
C
87/12
W. Covina
Pomona
F
58/10
B
80/11
Bag 2
75/15
Bag I
84/8
San Bernardino
Riverside
Riverside
138/18
Fullerton
80/15
Bag 4
68/8
146/16
135/16
110/15
90/17
78/8
Corona
Spiral 2
76/9
71/8
80/7
64/5
G
Anaheim
Los Angeles
Orange
Riverside
Orange

A → B 2200

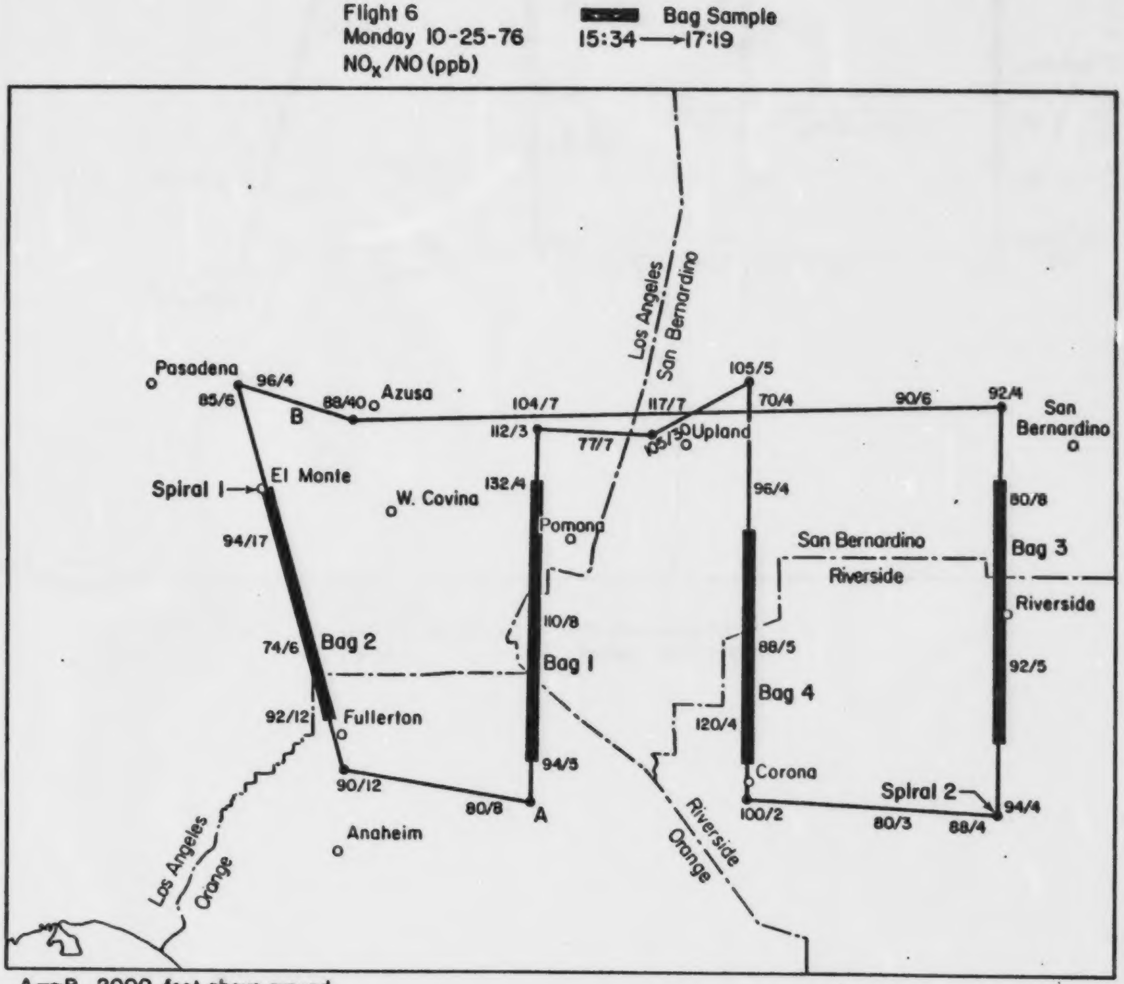
Flight 6
Monday 10-25-76
O_3 (ppb)

▬ Bag Sample
15:34 ⟶ 17:19


Pasadena
130
B
75
Azusa
130
150
110
230
205
210
San Bernardino
Spiral 1 ⟶
El Monte
75
65
Bag 2
100
Fullerton
60
130
Anaheim
W. Covina
165
Pomona
110
Bag 1
160
A
210
Upland
80
100
Bag 4
200
Corona
220
240
Spiral 2
235
Bag 3
225
Riverside
Los Angeles
San Bernardino
Riverside
Orange
Los Angeles
Orange

A ⟶ B 2000 feet above ground

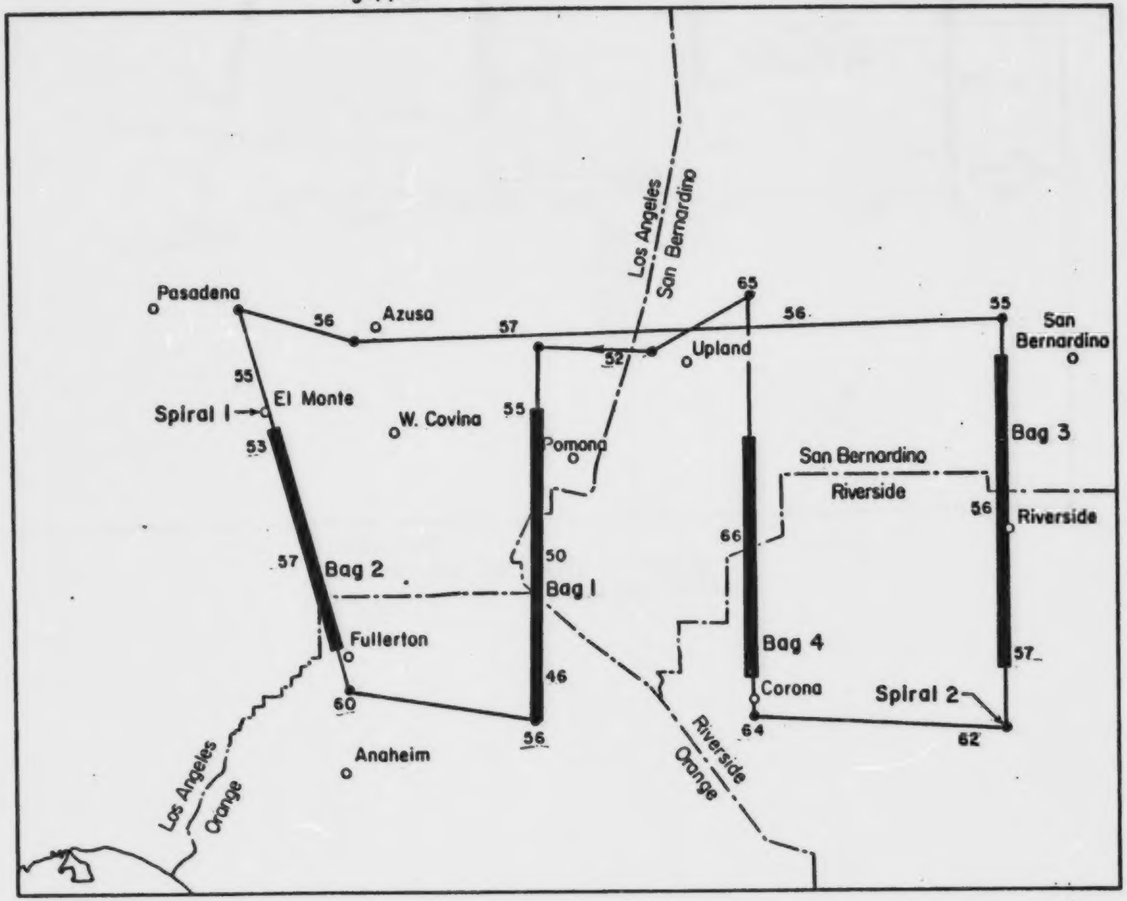
Flight 6
Monday 10-25-76
NO_x/NO (ppb)


Bag Sample
15:34 → 17:19
Pasadena
96/4
85/6
B
88/40
Azusa
104/7
117/7
105/5
70/4
90/6
92/4
San Bernardino
112/3
77/7
105/5
Upland
Spiral 1
El Monte
W. Covina
132/4
Pomona
96/4
80/8
94/17
Los Angeles
San Bernardino
Bag 3
Riverside
74/6
Bag 2
110/8
Bag 1
88/5
Bag 4
92/5
92/12
Fullerton
120/4
Corona
90/12
94/5
Spiral 2
80/8
A
100/2
80/3
88/4
94/4
Anaheim
Los Angeles
Orange
Riverside
Orange

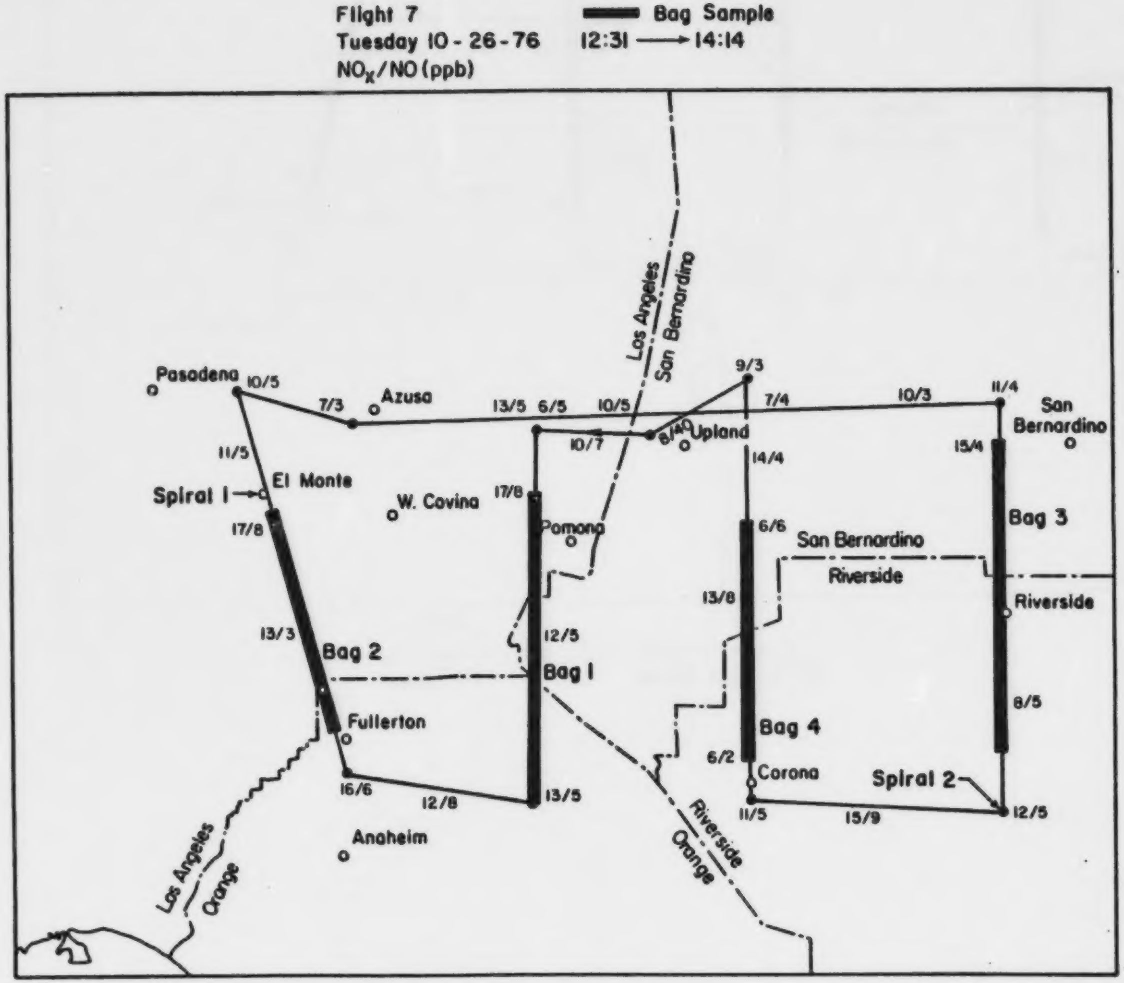
A → B 2000 feet above ground

Flight 7
Tuesday 10-26-76
O_3 (ppb)

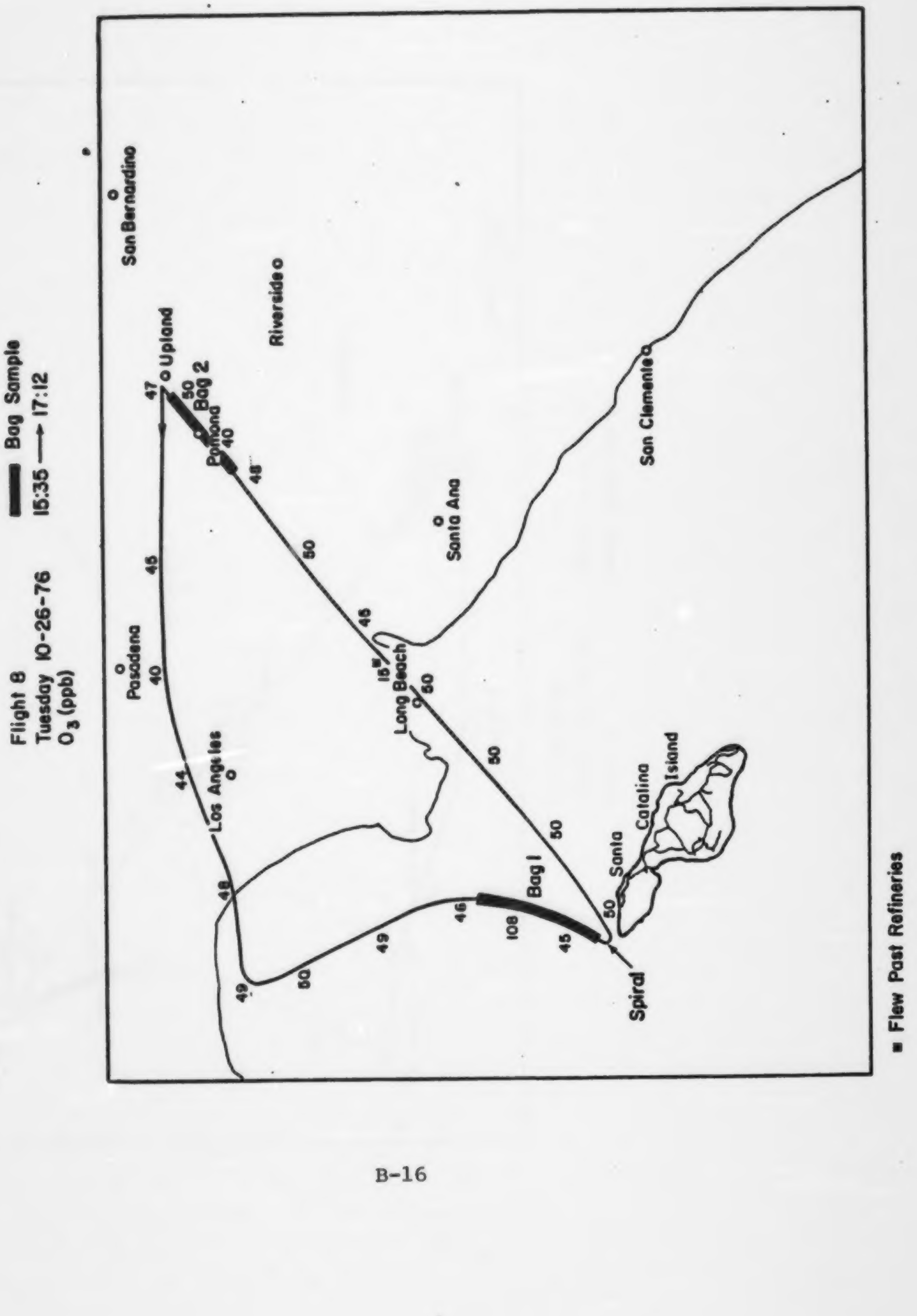
▬ Bag Sample
12:31 ⟶ 14:14

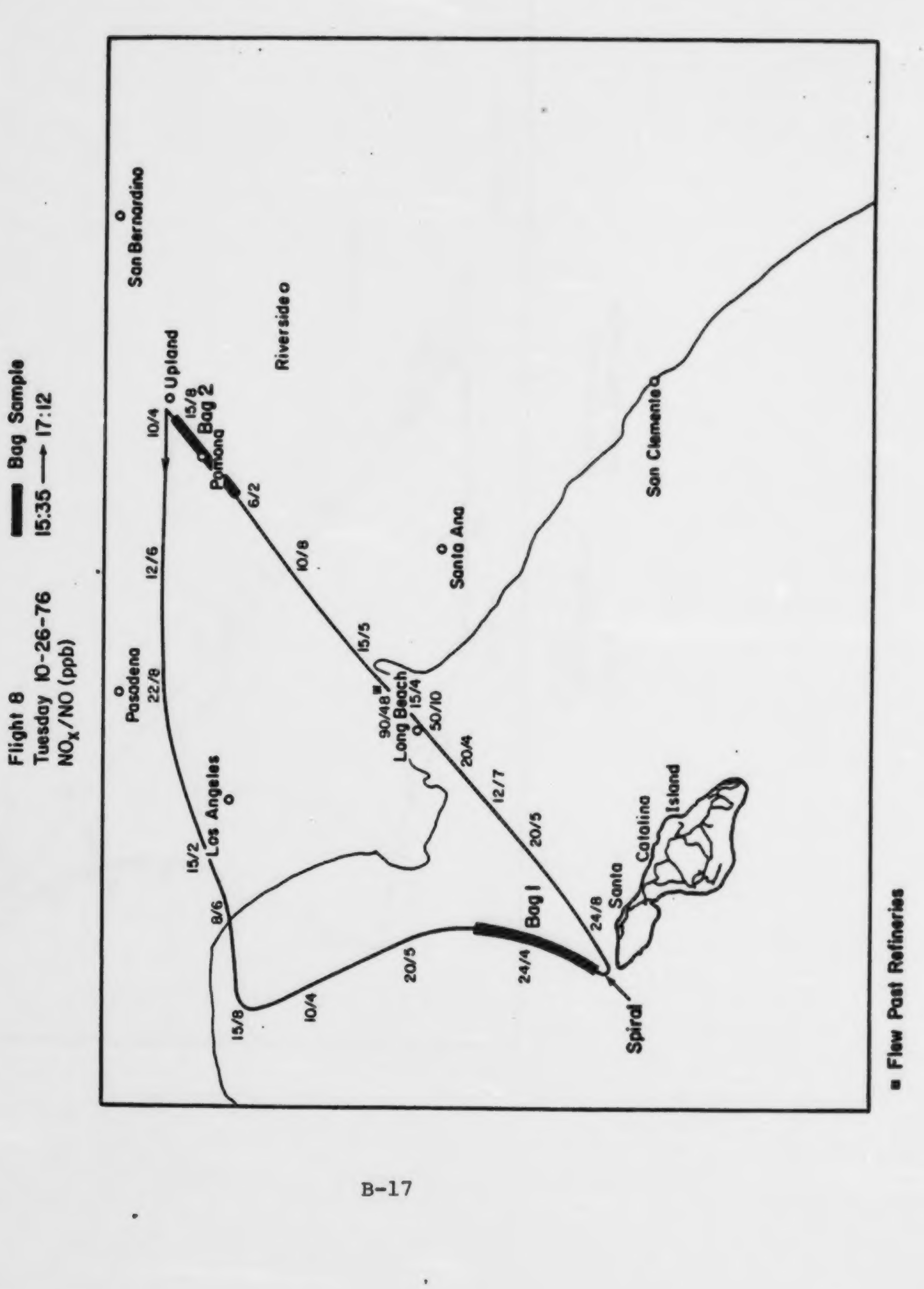

Pasadena
Azusa
56
57
56
55
65
San Bernardino
Los Angeles
San Bernardino
Upland
52
55
El Monte
Spiral 1
53
W. Covina
55
Pomona
Bag 3
San Bernardino
Riverside
56
Riverside
66
57
Bag 2
50
Bag 1
Fullerton
Bag 4
46
Corona
57
Spiral 2
60
56
64
62
Anaheim
Riverside
Orange
Los Angeles
Orange

Flight 7
Tuesday 10 - 26 - 76
NO_x/NO (ppb)



▬ Bag Sample
12:31 ⟶ 14:14
Pasadena
10/5
7/3
Azusa
13/5
6/5
10/5
9/3
7/4
10/3
11/4
San Bernardino
11/5
Spiral 1
El Monte
W. Covina
17/8
10/7
6/4
Upland
14/4
15/4
17/8
Pomona
6/6
San Bernardino
Riverside
Bag 3
Los Angeles
San Bernardino
13/3
Bag 2
12/5
Bag 1
13/8
Riverside
Fullerton
Bag 4
8/5
6/2
Corona
Spiral 2
16/6
12/8
13/5
11/5
15/9
12/5
Anaheim
Riverside
Orange
Los Angeles
Orange


Flight 8
Tuesday 10-26-76
O3 (ppb)
Bag Sample
15:35 ⟶ 17:12
San Bernardino
Upland
Riverside
Pomona
Bag 2
Pasadena
Los Angeles
Long Beach
Santa Ana
San Clemente
Santa Catalina Island
Bag 1
Spiral
47
50
40
48
45
50
46
15
50
40
44
48
50
50
50
46
108
45
49
50
49
■ Flew Past Refineries



Flight 8
Tuesday 10-26-76
NO_x/NO (ppb)

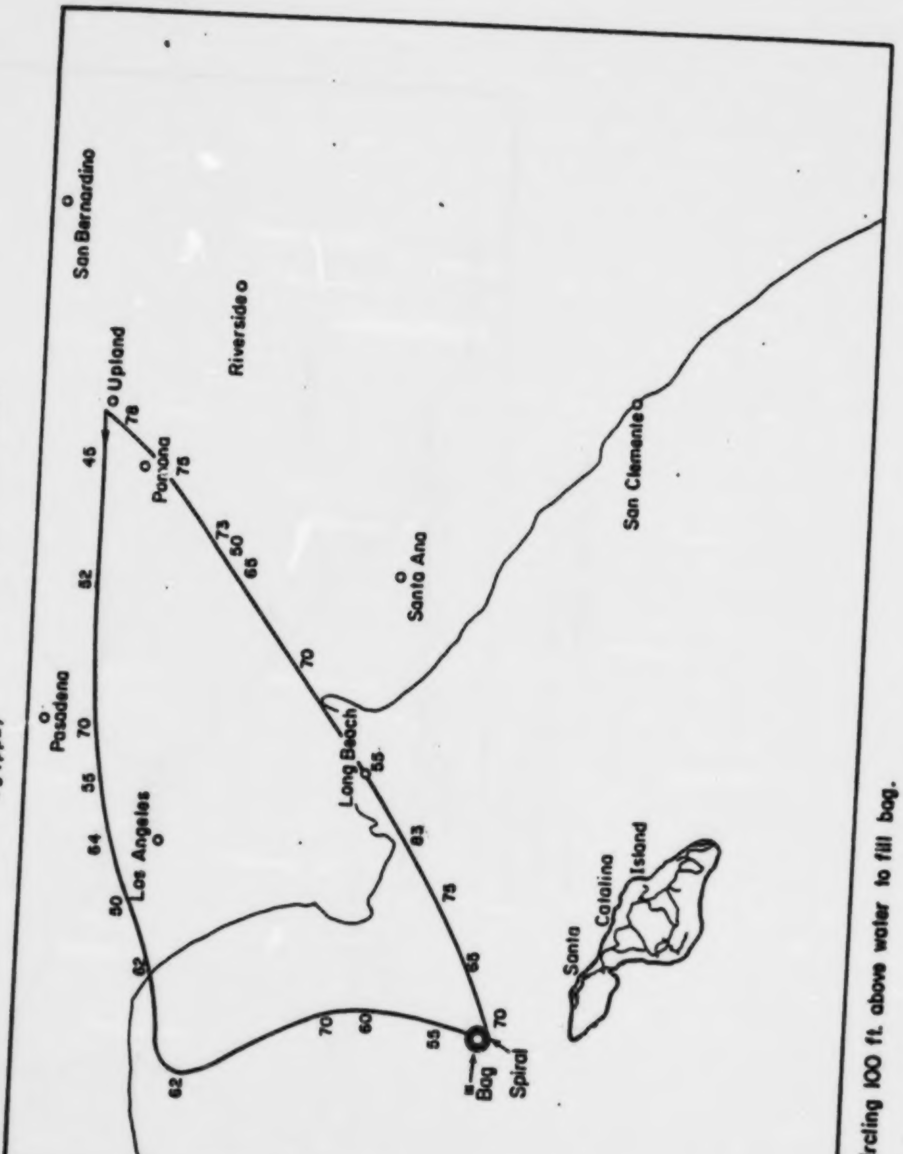
Bag Sample
15:35 ⟶ 17:12

■ Flew Past Refineries

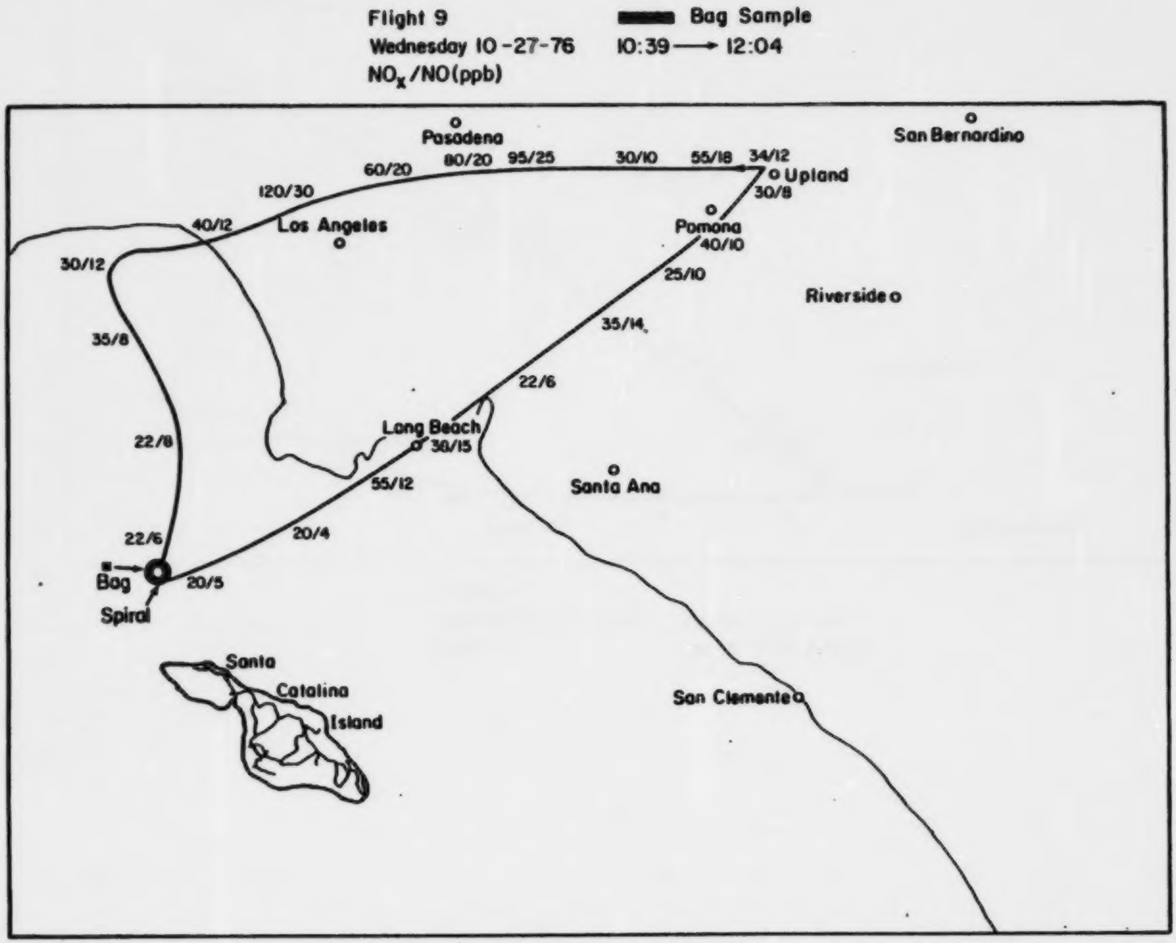
San Bernardino
Upland
Riverside
10/4
15/8
Bag 2
Pomona
6/2
10/8
Santa Ana
San Clemente
12/6
15/5
Pasadena
22/8
90/48
Long Beach
15/4
50/10
20/4
12/7
20/5
Los Angeles
15/2
8/6
Santa Catalina Island
24/8
Bag 1
20/5
24/4
10/4
15/8
Spiral

Flight 9
Wednesday 10-27-76
O_3 (ppb)

▬ Bag Sample
10:39 ⟶ 12:04


San Bernardino
Riverside
Upland
Pomona
Pasadena
Los Angeles
Santa Ana
Long Beach
San Clemente
Santa Catalina Island
*Bag
Spiral
45
52
70
55
64
50
62
78
75
73
50
65
70
55
83
75
65
70
70
60
55
62

*Circling 100 ft. above water to fill bag.



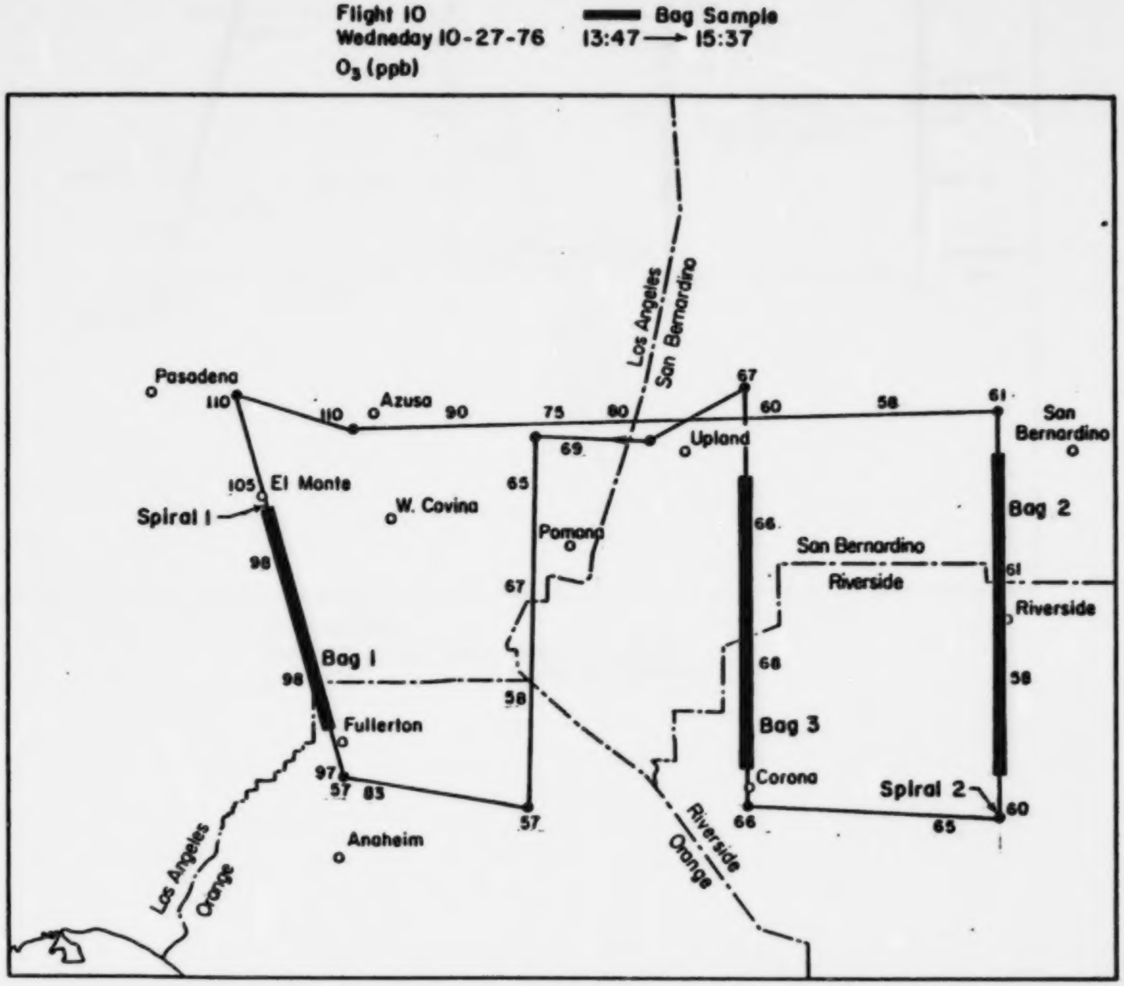
Flight 9
Wednesday 10-27-76
NO_x/NO(ppb)

▬ Bag Sample
10:39 → 12:04

Pasadena
San Bernardino
Upland
Pomona
Los Angeles
Riverside
Long Beach
Santa Ana
San Clemente
Santa Catalina Island
Bag
Spiral
120/30
60/20
80/20
95/25
30/10
55/18
34/12
30/8
40/10
25/10
35/14
22/6
30/15
55/12
20/4
20/5
40/12
30/12
35/8
22/8
22/6

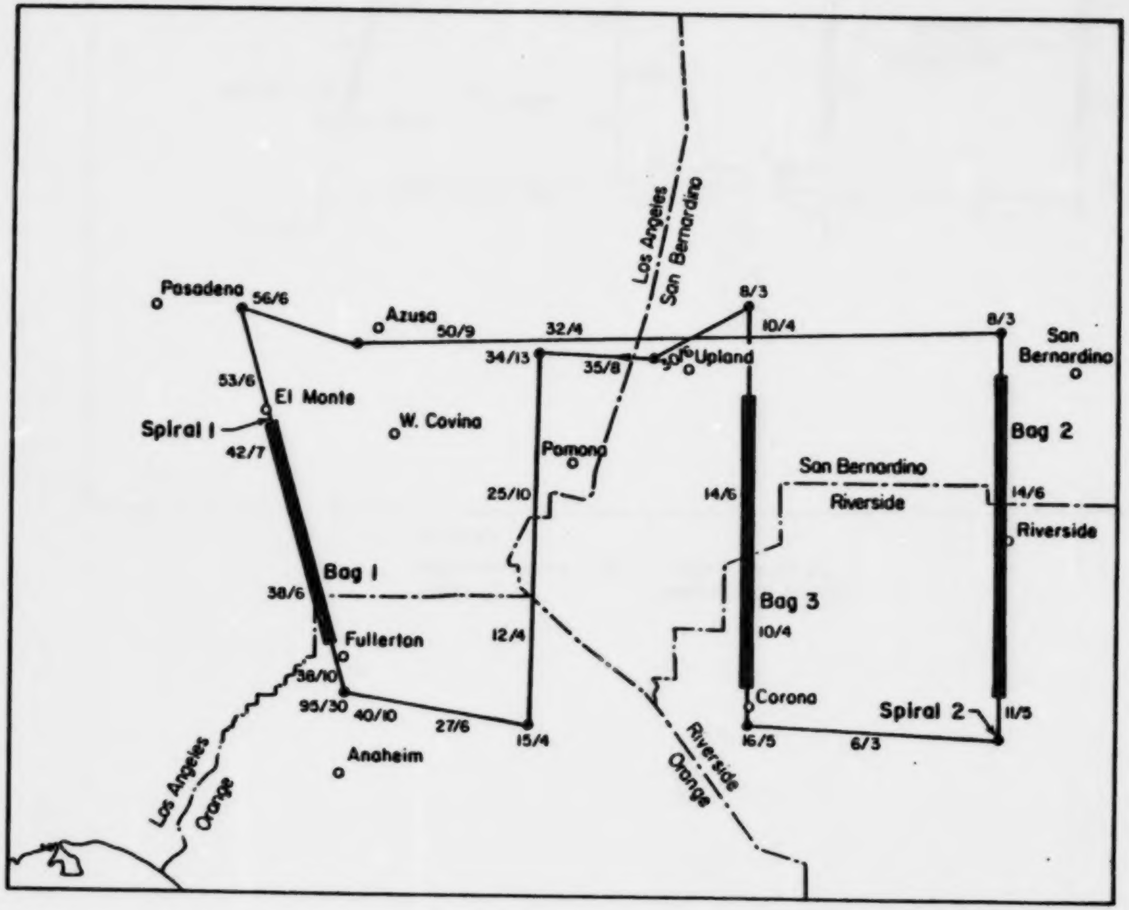
*Circling 100 ft. above water to fill bag.

Flight 10
Wednesday 10-27-76
O_3 (ppb)


Bag Sample
13:47 → 15:37
Pasadena
110
110
Azusa
90
75
80
67
60
58
61
San Bernardino
Los Angeles
San Bernardino
69
Upland
105
El Monte
Spiral 1
W. Covina
65
Pomona
66
Bag 2
San Bernardino
Riverside
61
Riverside
98
67
Bag 1
98
58
68
58
Fullerton
Bag 3
97
57
83
Corona
Spiral 2
60
57
66
65
Anaheim
Los Angeles
Orange
Riverside
Orange

Flight 10
Wednesday 10-27-76
NO_x/NO (ppb)

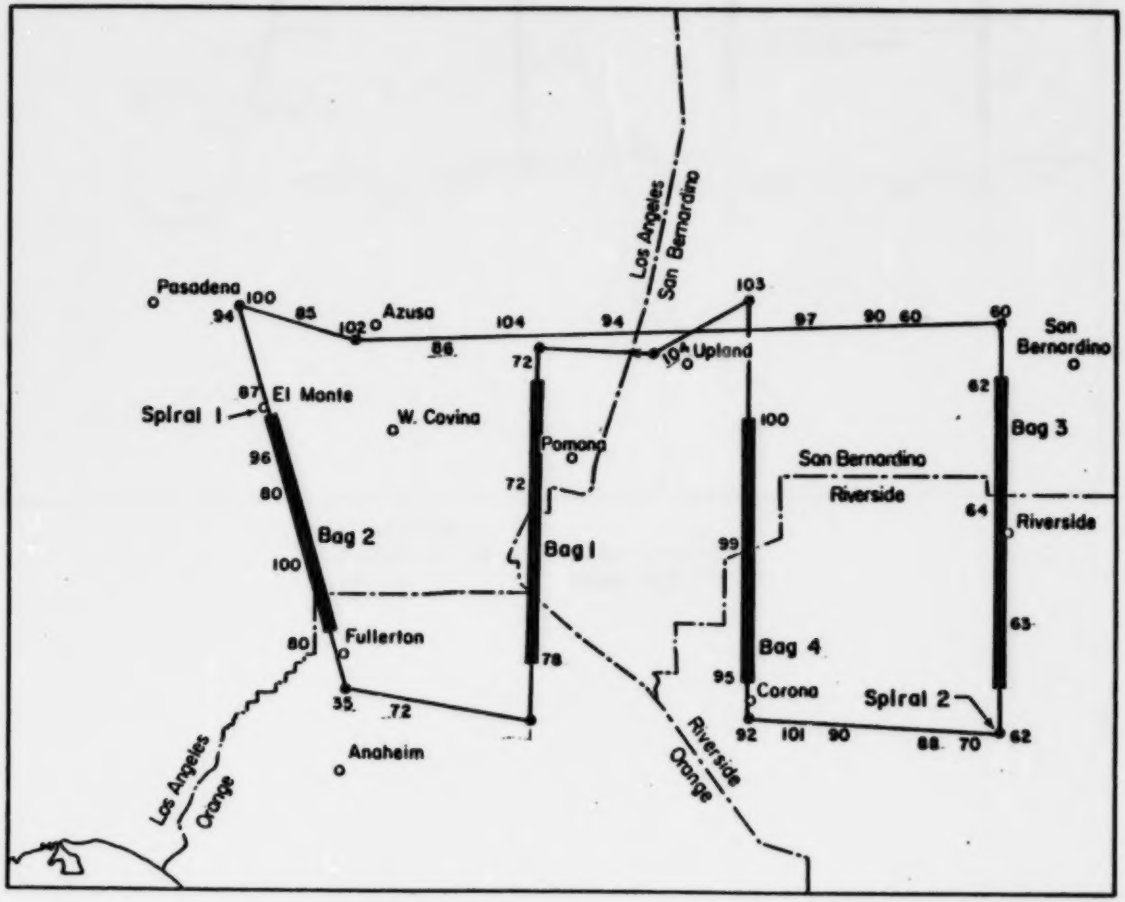
▬ Bag Sample
13:47 → 15:37

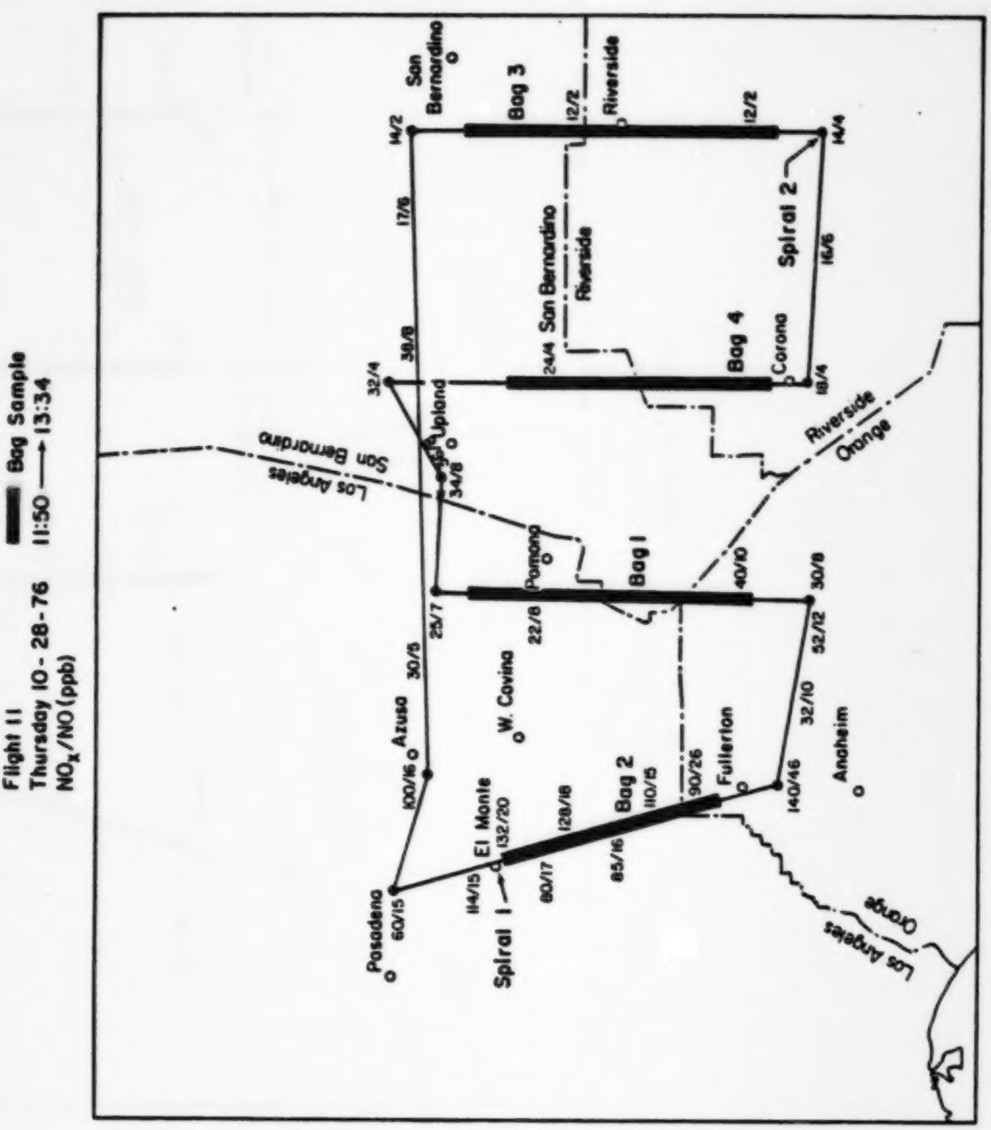


Pasadena
56/6
Azusa
50/9
32/4
34/13
35/8
30/6
Upland
8/3
10/4
8/3
San Bernardino
Los Angeles
San Bernardino
53/6
El Monte
Spiral 1
42/7
W. Covina
Pomona
25/10
Bag 1
38/6
Fullerton
12/4
38/10
95/30
40/10
27/6
15/4
Anaheim
Los Angeles
Orange
14/6
Bag 3
10/4
Corona
16/5
6/3
Spiral 2
11/5
Bag 2
14/6
San Bernardino
Riverside
Riverside
Riverside
Orange

Flight 11
Thursday 10-28-76, 11:50 ⟶ 13:34
O_3 (ppb)

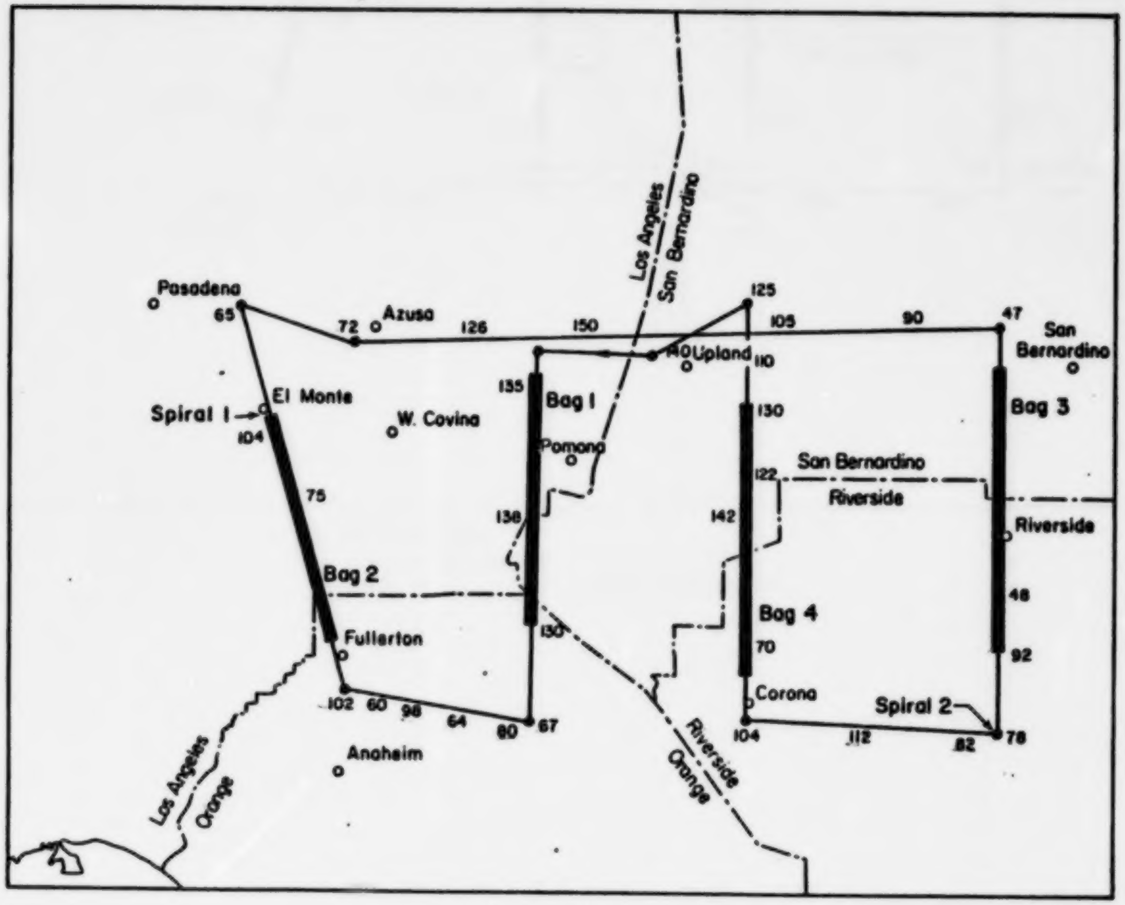
▬ Bag Sample

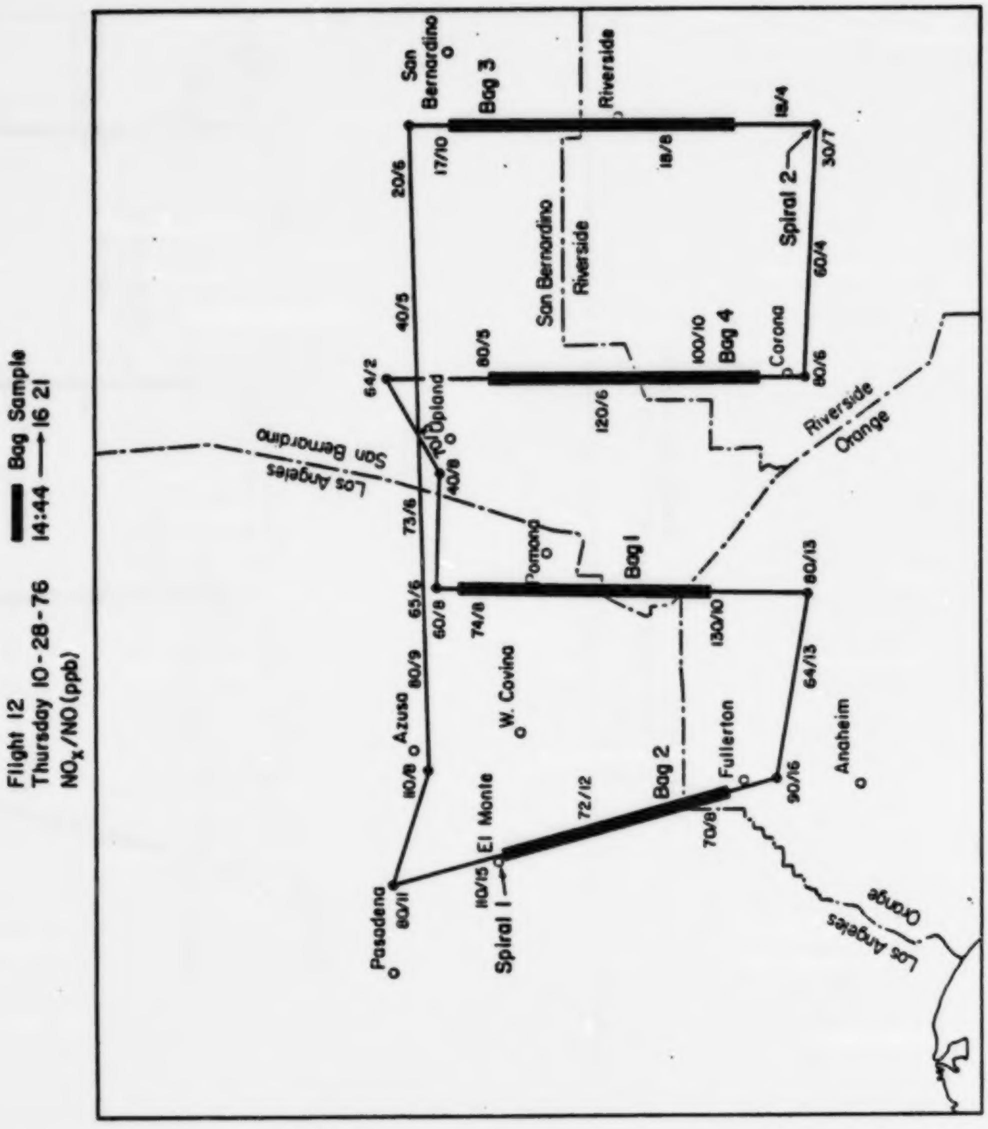

Pasadena
100
94
85
102
Azusa
86
104
94
103
97
90
60
60
San Bernardino
72
104
Upland
Los Angeles
San Bernardino
87
El Monte
Spiral 1
W. Covina
Pomona
62
Bag 3
100
96
80
72
San Bernardino
Riverside
64
Riverside
Bag 2
Bag 1
99
100
80
Fullerton
78
Bag 4
95
Corona
63
Spiral 2
35
72
92
101
90
88
70
62
Anaheim
Riverside
Orange
Los Angeles
Orange


Flight 11
Thursday 10-28-76
NO_x/NO (ppb)
Bag Sample
11:50 ⟶ 13:34
Pasadena
60/15
Spiral 1
114/15
El Monte
132/20
80/17
128/18
85/16
Bag 2
110/15
90/26
Fullerton
140/46
Anaheim
100/16
Azusa
W. Covina
30/5
32/10
25/7
22/8
32/12
Pomona
Bag 1
40/10
30/8
Los Angeles
San Bernardino
34/8
35/8
Upland
32/4
38/8
24/4
San Bernardino
Riverside
Bag 4
Corona
18/4
Riverside
Orange
17/6
16/6
Spiral 2
14/2
San Bernardino
Bag 3
12/2
Riverside
12/2
14/4
Los Angeles
Orange

Flight 12
Thursday 10-28-76
O_3 (ppb)

▬ Bag Sample
14:44 → 16:21


Pasadena
65
72
Azusa
126
150
125
105
90
47
San Bernardino
Los Angeles
San Bernardino
140
Upland
110
Spiral 1
El Monte
104
W. Covina
135
Bag 1
Pomona
130
Bag 3
San Bernardino
Riverside
122
Riverside
75
138
142
Bag 2
48
Bag 4
130
Fullerton
70
92
Corona
Spiral 2
102
60
98
64
80
67
104
112
82
78
Anaheim
Riverside
Orange
Los Angeles
Orange

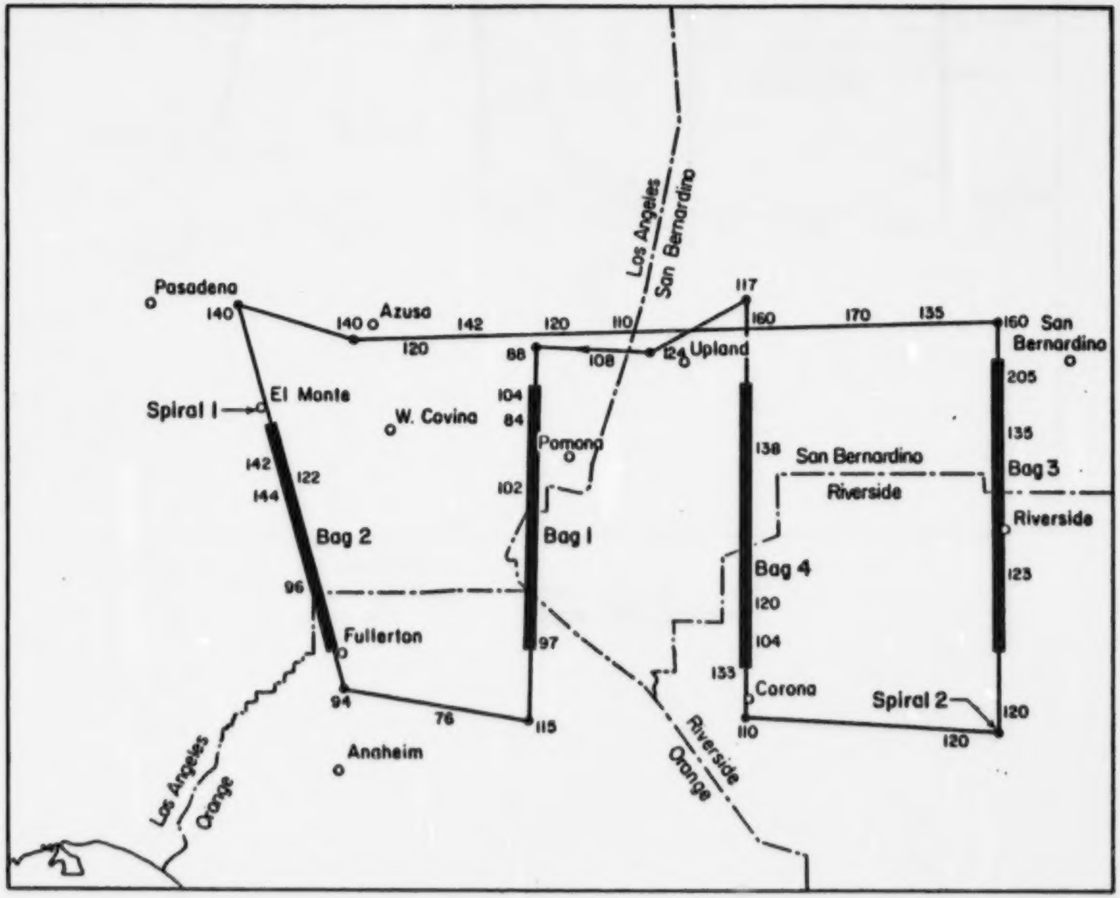


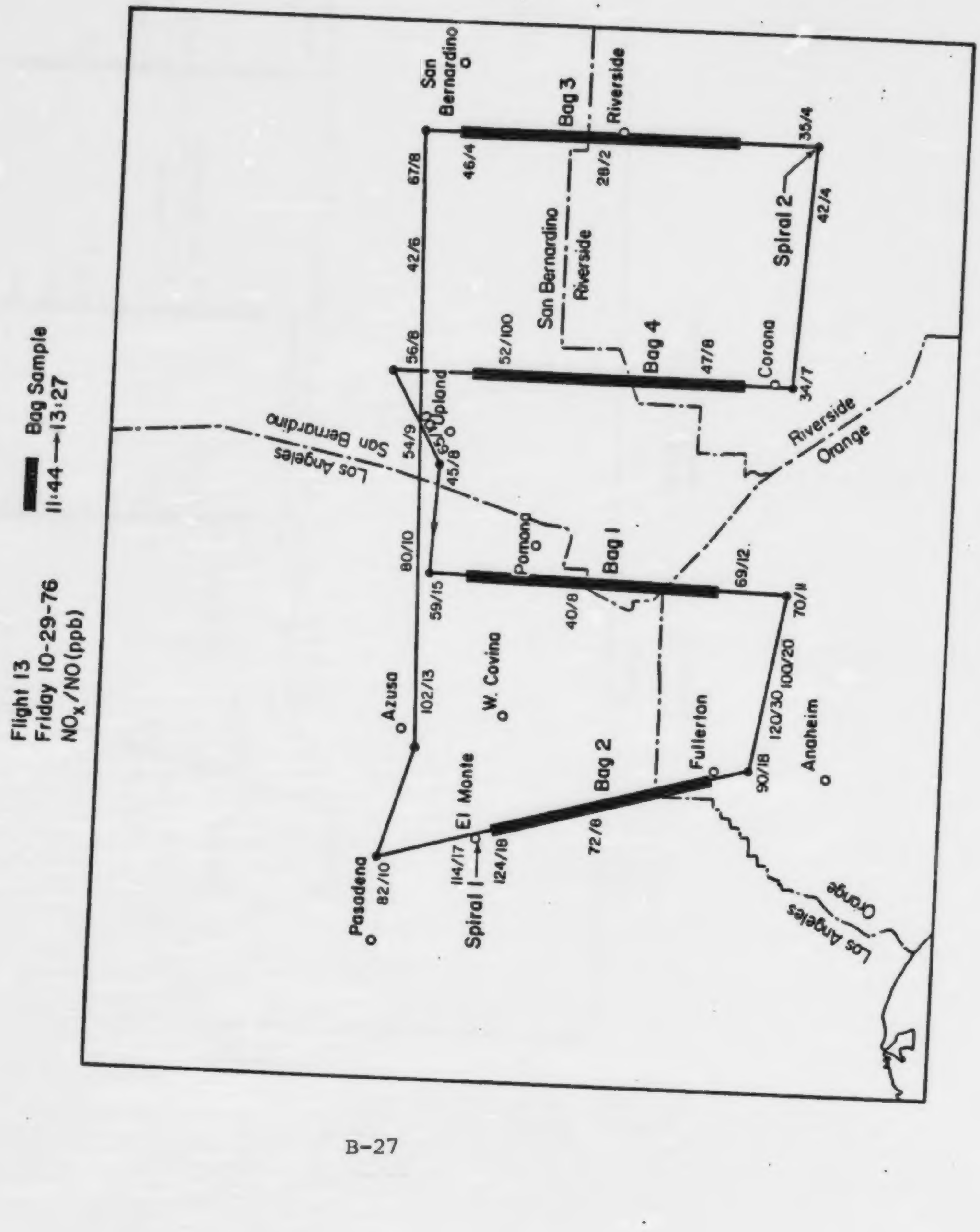
Flight 12
Thursday 10-28-76
NO_x/NO (ppb)

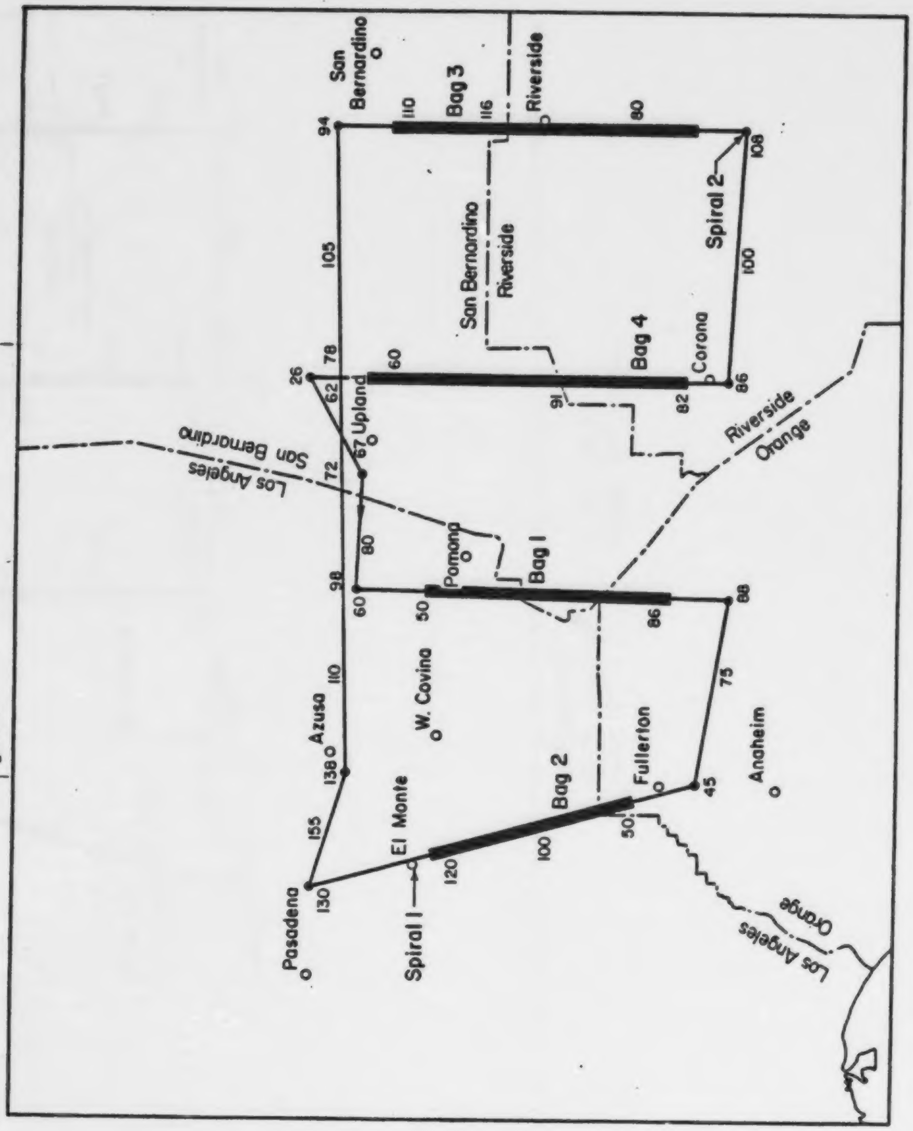
Bag Sample
14:44 → 16 21
Pasadena
80/11
Spiral 1
110/15
El Monte
110/8
Azusa
80/9
W. Covina
72/12
Bag 2
70/8
Fullerton
90/16
Anaheim
64/13
60/8
65/6
74/8
Pomona
Bag 1
130/10
80/13
73/6
40/8
Opland
101
64/2
Los Angeles
San Bernardino
80/5
120/6
100/10
Bag 4
Corona
80/6
40/5
San Bernardino
Riverside
60/4
Spiral 2
30/7
20/6
17/10
Bag 3
18/8
18/4
San Bernardino
Riverside
Riverside
Orange
Los Angeles
Orange

Flight 13
Friday 10-29-76
O_3 (ppb)

▬ Bag Sample
11:44 → 13:27


Pasadena
140
140
Azusa
142
120
120
110
117
160
170
135
160
San Bernardino
Los Angeles
San Bernardino
Spiral 1
El Monte
W. Covina
88
108
124
Upland
104
84
Pomona
102
Bag 1
97
142
144
122
Bag 2
96
Fullerton
94
76
115
Anaheim
138
San Bernardino
Riverside
Bag 4
120
104
133
Corona
110
205
135
Bag 3
Riverside
123
Spiral 2
120
120
Riverside
Orange
Los Angeles
Orange


Flight 13
Friday 10-29-76
NO_x/NO (ppb)
Bag Sample
11:44 ⟶ 13:27
Pasadena
82/10
Azusa
102/13
80/10
54/9
56/8
42/6
67/8
San Bernardino
Spiral 1
114/17
124/18
El Monte
W. Covina
59/15
Pomona
45/8
Upland
52/100
46/4
Bag 2
72/8
Fullerton
40/8
Bag 1
Bag 4
Bag 3
San Bernardino
Riverside
28/2
Riverside
90/18
120/30
100/20
70/11
69/12
47/8
Corona
34/7
Spiral 2
42/4
35/4
Anaheim
Los Angeles
San Bernardino
Riverside
Orange
Los Angeles
Orange



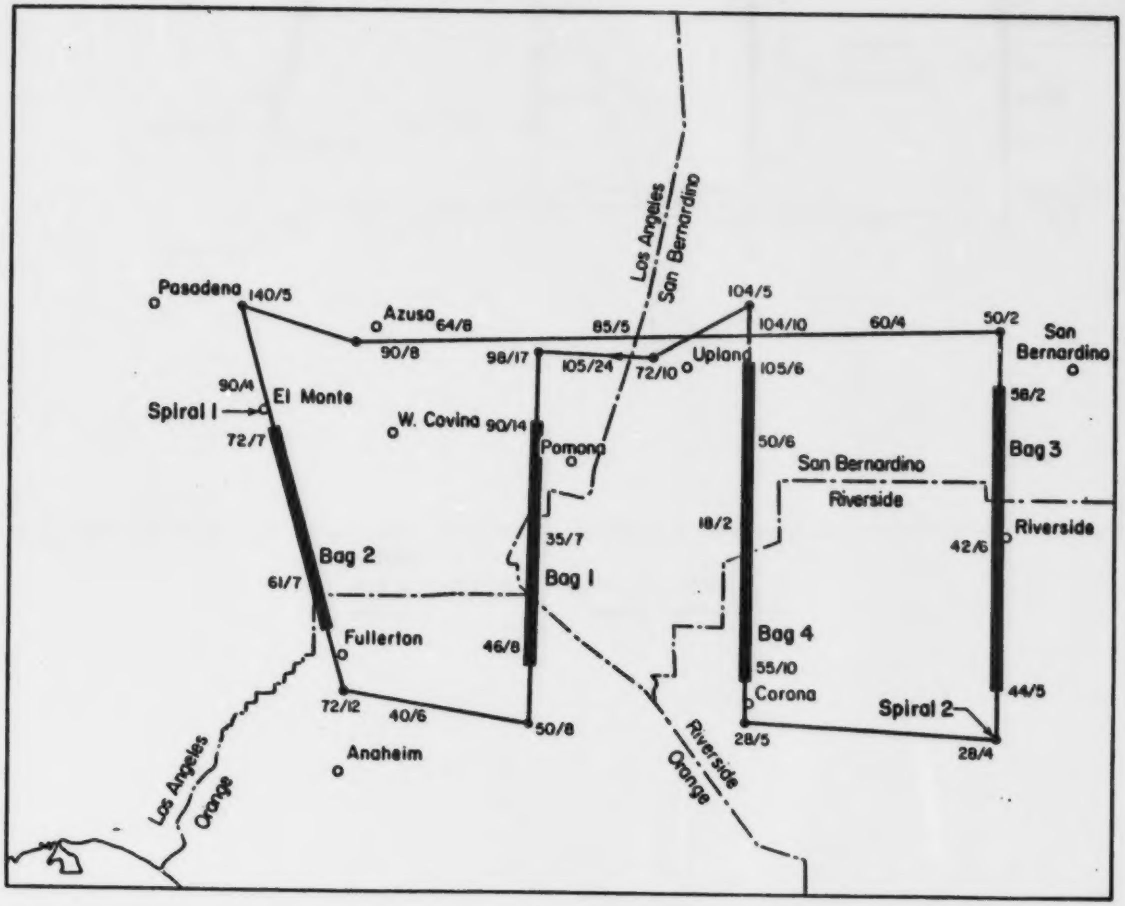
Flight 14
Friday 10-29-76
O_3 (ppb)

▬ Bag Sample
14:45 → 16:28

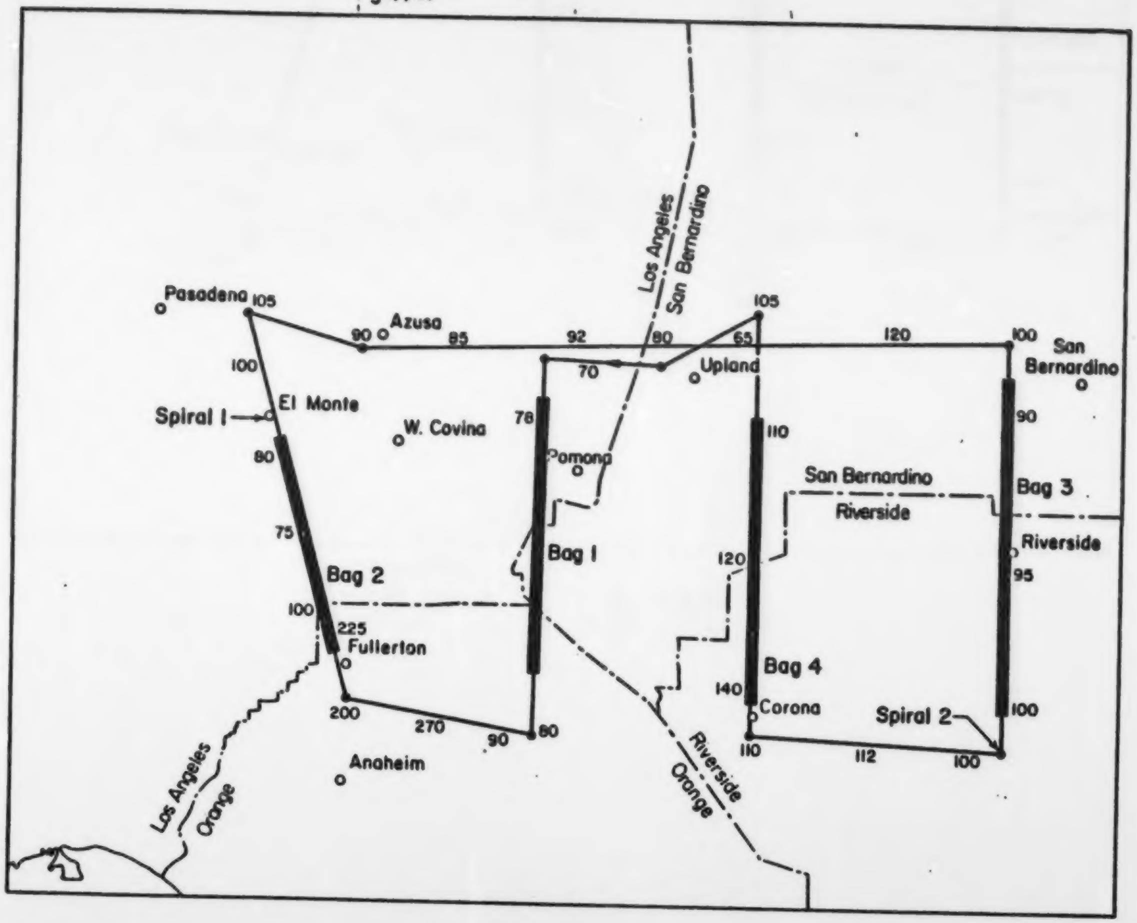
Pasadena
130
155
138
Azusa
110
98
60
80
72
67 Upland
62
26
78
105
94
San Bernardino
El Monte
Spiral 1
120
100
Bag 2
50
Fullerton
45
Anaheim
75
88
86
Bag 1
50
Pomona
W. Covina
60
Bag 4
91
82
Corona
86
100
Spiral 2
108
80
Riverside
116
Bag 3
110
San Bernardino
Riverside
Los Angeles
San Bernardino
Riverside
Orange
Los Angeles
Orange

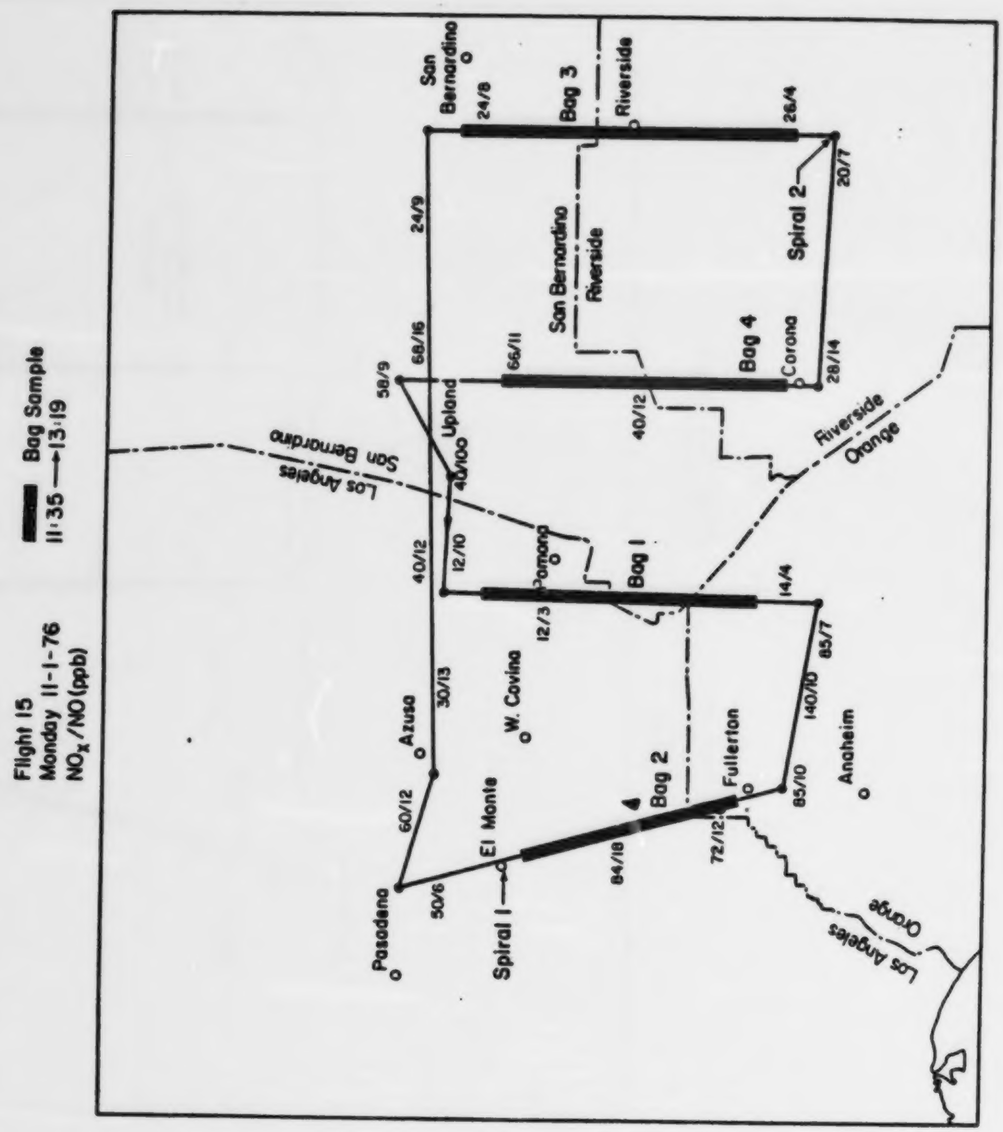
Flight 14
Friday 10-29-76
NO_x/NO(ppb)

▬ Bag Sample
14:45→16:28


Pasadena
140/5
Azusa
64/8
90/8
85/5
104/5
104/10
60/4
50/2
San Bernardino
Los Angeles
San Bernardino
98/17
105/24
72/10
Upland
105/6
58/2
90/4
El Monte
Spiral 1
72/7
W. Covina
90/14
Pomona
50/6
San Bernardino
Riverside
Bag 3
35/7
18/2
42/6
Riverside
Bag 2
61/7
Bag 1
Bag 4
Fullerton
46/8
55/10
Corona
44/5
Spiral 2
72/12
40/6
50/8
28/5
28/4
Anaheim
Riverside
Orange
Los Angeles
Orange

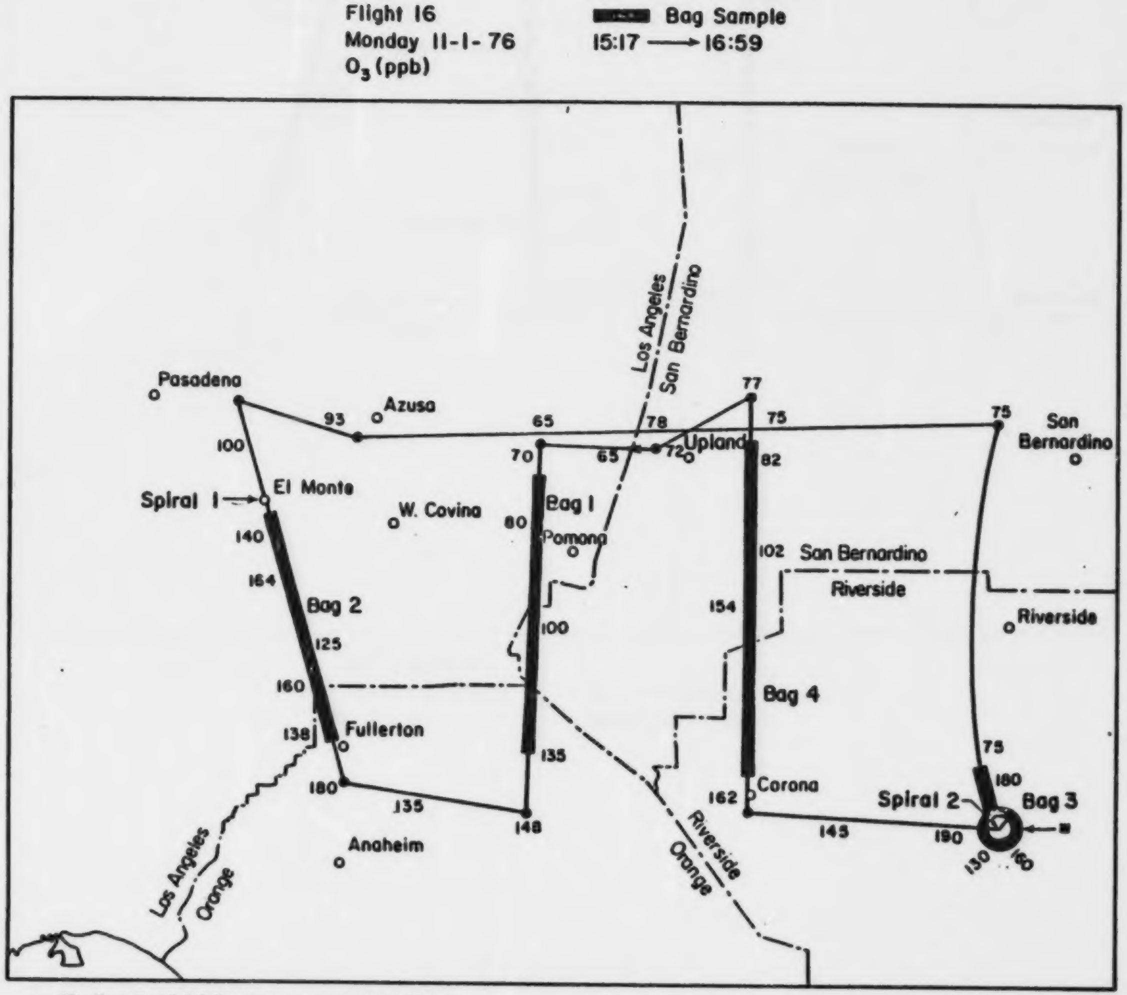
Flight 15
Monday 11-1-76
O_3 (ppb)


Bag Sample
11:35 → 13:19
Pasadena
105
Azusa
90
85
92
80
105
65
120
100
San Bernardino
100
El Monte
Spiral 1
W. Covina
70
Upland
78
Pomona
110
90
80
Los Angeles
San Bernardino
San Bernardino
Riverside
Bag 3
75
Bag 2
Bag 1
120
Riverside
95
100
225
Fullerton
Bag 4
140
Corona
Spiral 2
100
200
270
90
80
110
112
100
Anaheim
Los Angeles
Orange
Riverside
Orange

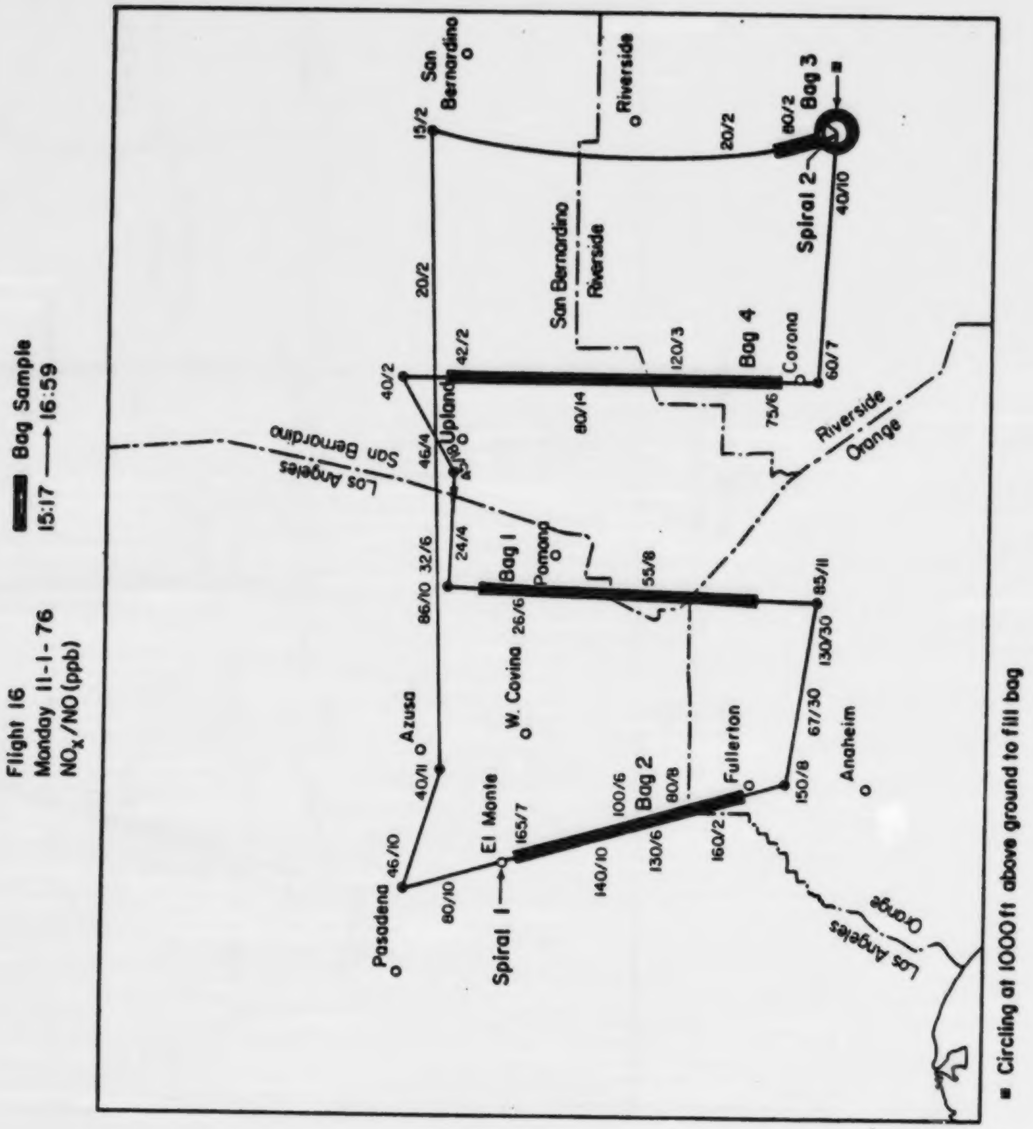


Flight 15
Monday 11-1-76
NO_x/NO(ppb)
Bag Sample
11:35 ⟶ 13:19
Pasadena
Spiral 1
El Monte
Azusa
W. Covina
Pomona
Upland
San Bernardino
Riverside
Corona
Spiral 2
Fullerton
Anaheim
Bag 1
Bag 2
Bag 3
Bag 4
50/6
60/12
84/18
72/12
85/10
140/10
85/7
14/4
30/13
12/3
40/12
12/10
40/100
58/9
68/16
66/11
40/12
28/14
24/9
24/8
26/4
20/7
Los Angeles
San Bernardino
Riverside
Orange

Flight 16
Monday 11-1-76
O_3 (ppb)

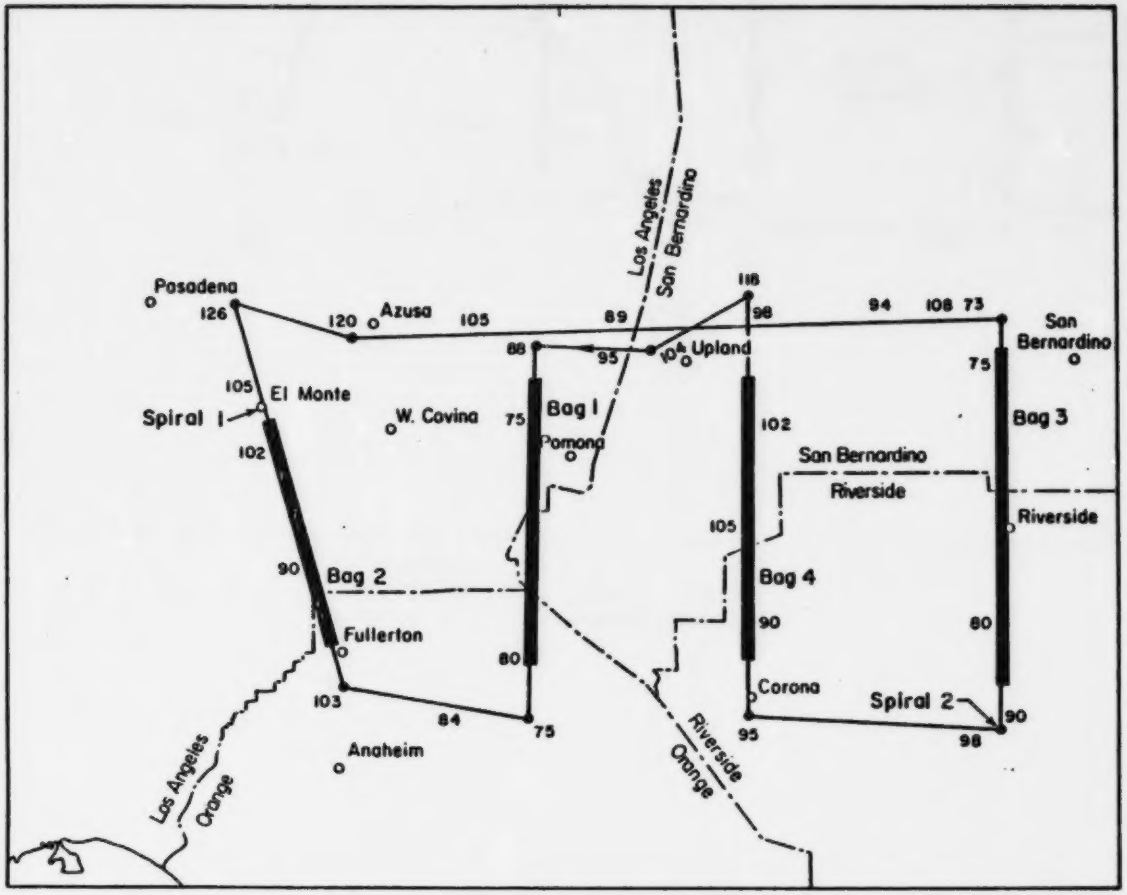

▬ Bag Sample
15:17 ⟶ 16:59
Pasadena
Azusa
El Monte
Spiral 1
W. Covina
Pomona
Upland
San Bernardino
Riverside
Fullerton
Anaheim
Corona
Spiral 2
Bag 1
Bag 2
Bag 3
Bag 4
Los Angeles
San Bernardino
Riverside
Orange
Los Angeles
Orange
100
93
65
78
77
75
75
70
65
72
82
140
164
125
160
138
180
135
148
80
100
135
102
154
162
145
190
75
180
130
160

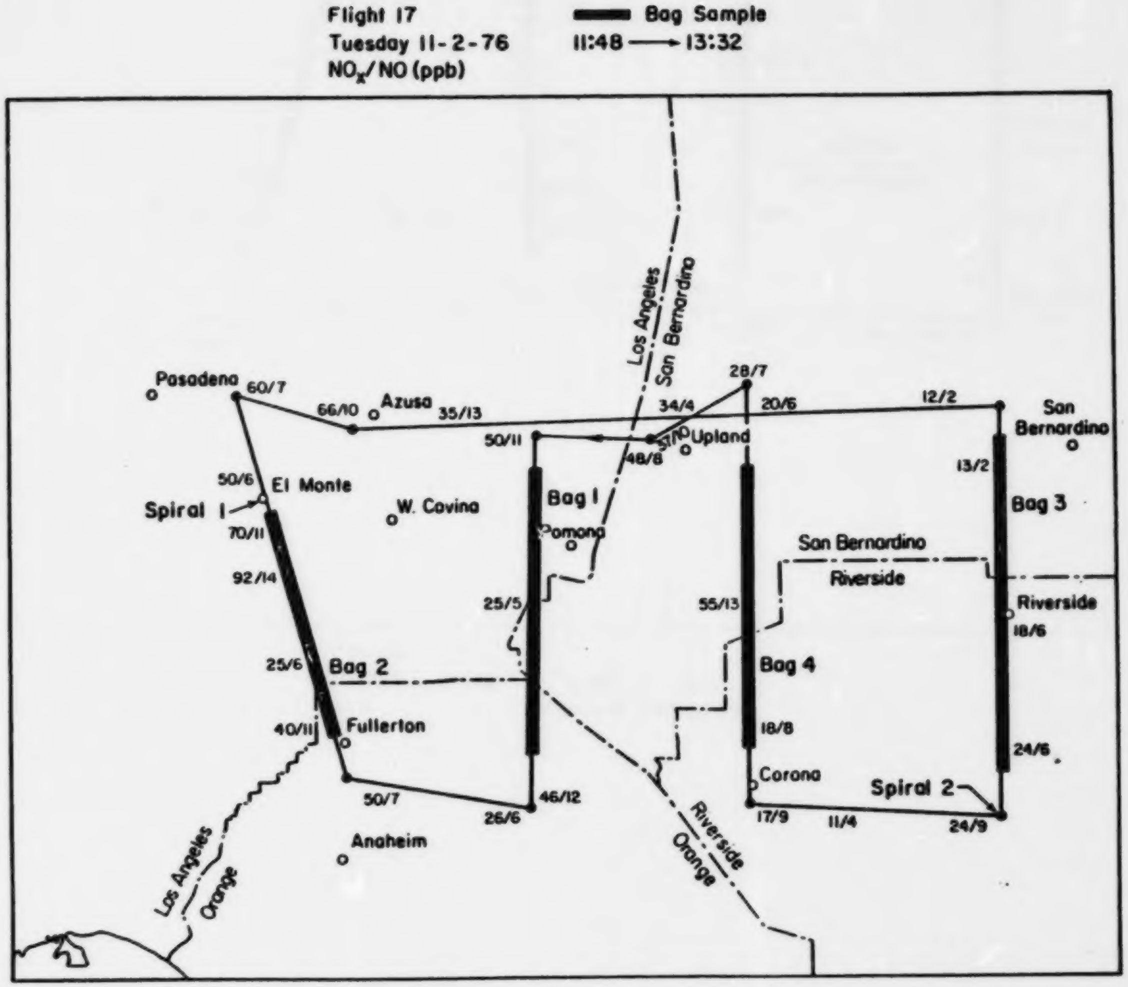
■ Circling at 1000 ft above ground to fill bag

Flight 16
Monday 11-1-76
NO_x/NO (ppb)
Bag Sample
15:17 ⟶ 16:59
Pasadena
46/10
40/11
Azusa
86/10
32/6
24/4
46/4
40/2
42/2
20/2
15/2
San Bernardino
Spiral 1
El Monte
80/10
165/7
140/10
130/6
100/6
Bag 2
80/8
160/2
Fullerton
150/8
Anaheim
67/30
130/30
85/11
W. Covina
26/6
Bag 1
Pomona
55/8
Upland
80/14
75/6
120/3
Bag 4
Corona
60/7
40/10
Spiral 2
Bag 3
80/2
20/2
Riverside
Los Angeles
San Bernardino
Riverside
Orange
Los Angeles
Orange
San Bernardino
Riverside
■ Circling at 1000ft above ground to fill bag

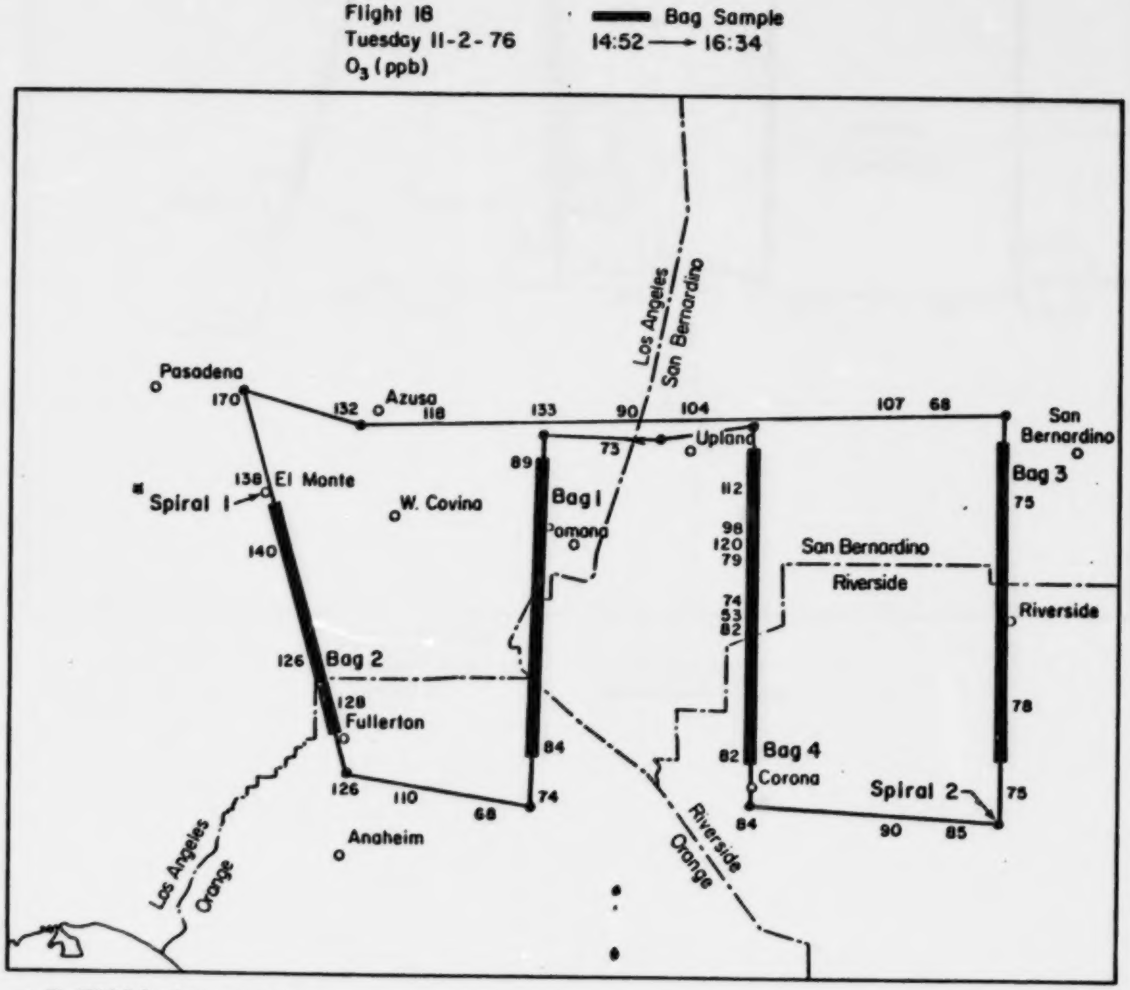
Flight 17
Tuesday 11-2-76
O_3 (ppb)

▬ Bag Sample
11:48 ⟶ 13:32


Pasadena
126
120
Azusa
105
89
Los Angeles
San Bernardino
118
98
94
108
73
San Bernardino
88
95
104
Upland
75
105
El Monte
Spiral 1
102
W. Covina
75
Bag 1
Pomona
102
San Bernardino
Riverside
Bag 3
Riverside
105
90
Bag 2
Bag 4
90
80
Fullerton
80
103
84
75
Corona
95
Spiral 2
90
98
Anaheim
Riverside
Orange
Los Angeles
Orange


Flight 17
Tuesday 11-2-76
NO_x/NO (ppb)
Bag Sample
11:48 → 13:32
Pasadena
60/7
66/10
Azusa
35/13
34/4
28/7
20/6
12/2
San Bernardino
50/6
El Monte
Spiral 1
70/11
92/14
W. Covina
50/11
Bag 1
Pomona
48/8
Upland
Los Angeles
San Bernardino
13/2
Bag 3
San Bernardino
Riverside
Riverside
18/6
25/5
55/13
25/6
Bag 2
Bag 4
40/11
Fullerton
18/8
24/6
Corona
Spiral 2
50/7
26/6
46/12
17/9
11/4
24/9
Anaheim
Riverside
Orange
Los Angeles
Orange

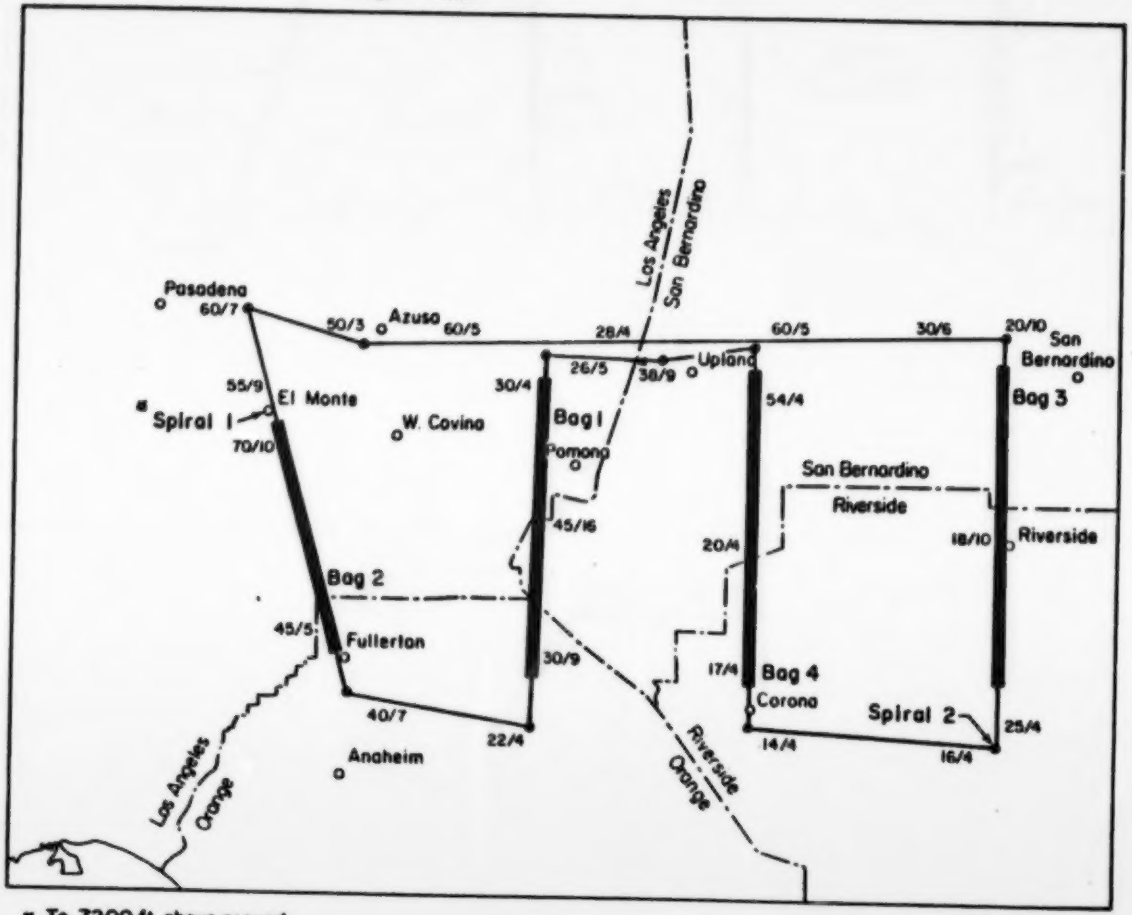
Flight 18
Tuesday 11-2-76
O_3 (ppb)


Bag Sample
14:52 ⟶ 16:34
Pasadena
170
132
Azusa
118
133
90
104
107
68
San Bernardino
138
El Monte
Spiral 1
W. Covina
89
Bag 1
Pomona
73
Upland
112
98
120
79
74
53
82
Bag 3
75
Los Angeles
San Bernardino
San Bernardino
Riverside
Riverside
140
126
Bag 2
128
Fullerton
84
82
Bag 4
Corona
78
Spiral 2
75
126
110
68
74
84
90
85
Anaheim
Riverside
Orange
Los Angeles
Orange

■ To 7200 ft above ground

Flight 18
Tuesday 11-2-76
NO_x/NO (ppb)

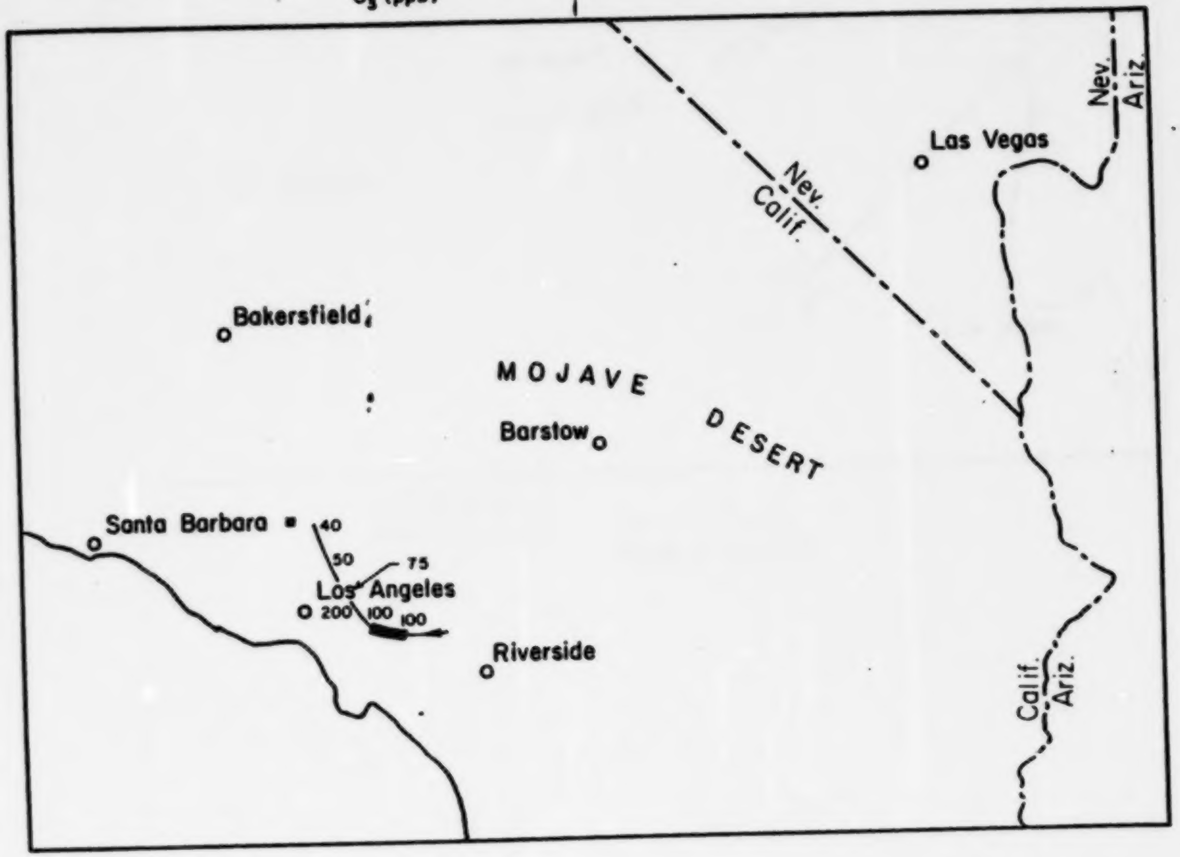
▬ Bag Sample
14:52 ⟶ 16:34


Pasadena
60/7
50/3
Azusa
60/5
28/4
60/5
30/6
20/10
San Bernardino
Los Angeles
San Bernardino
55/9
El Monte
Spiral 1
70/10
W. Covina
30/4
Bag 1
26/5
38/9
Upland
54/4
Bag 3
Pomona
San Bernardino
Riverside
45/16
20/4
18/10
Riverside
Bag 2
45/5
Fullerton
30/9
17/4
Bag 4
Corona
Spiral 2
25/4
40/7
22/4
14/4
16/4
Anaheim
Los Angeles
Orange
Riverside
Orange

■ To 7200 ft above ground

Flight 19
Wednesday 11-3-76
O_3 (ppb)

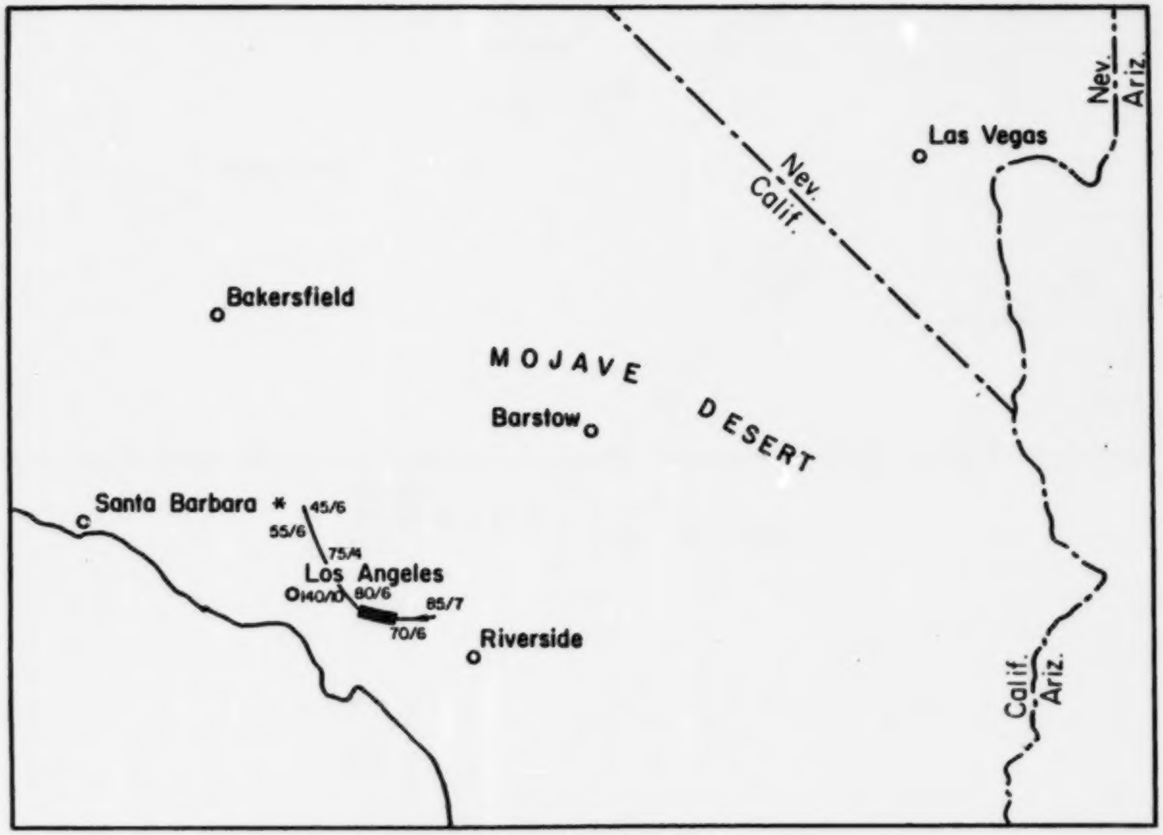
▬ Bag Sample
14:10 ⟶ 14:44


Nev.
Ariz.
Las Vegas
Nev.
Calif.
Bakersfield
MOJAVE DESERT
Barstow
Santa Barbara
40
50
75
Los Angeles
200
100
100
Riverside
Calif.
Ariz.

■ Power failure

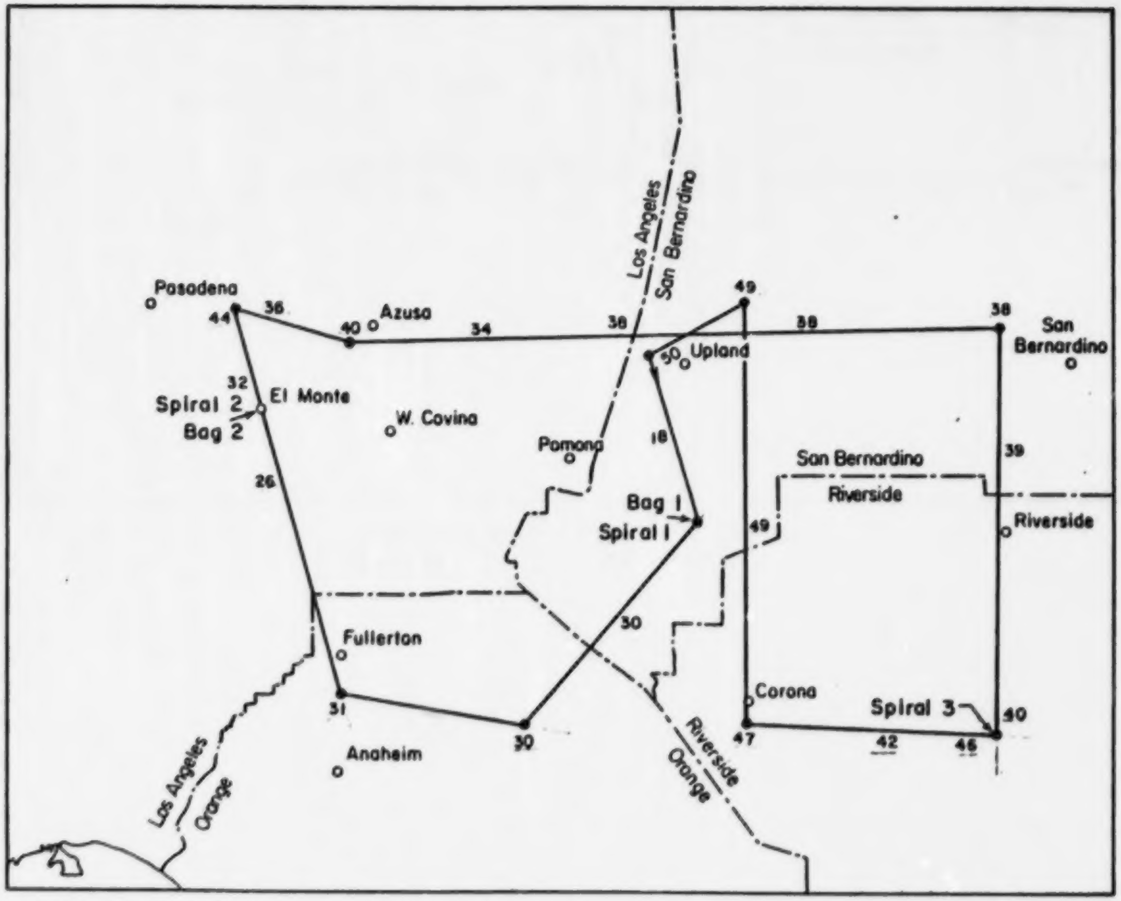
Flight 19
Wednesday 11-3-76
NO$_x$/NO (ppb)

▬ Bag Sample
14:10 ⟶ 14:44


Nev.
Ariz.
Las Vegas
Nev.
Calif.
Bakersfield
MOJAVE DESERT
Barstow
Santa Barbara
*
45/6
55/6
75/4
Los Angeles
140/10
80/6
85/7
70/6
Riverside
Calif.
Ariz.

* Power failure

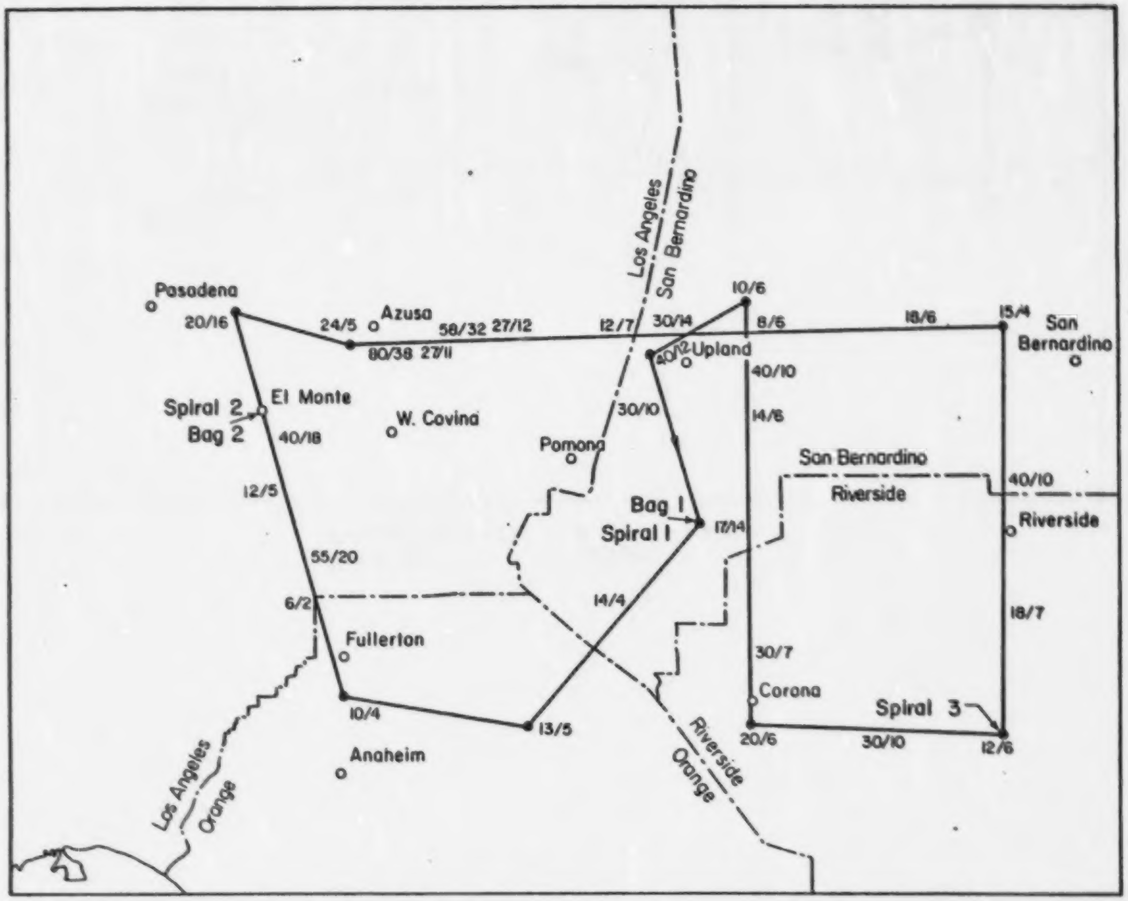
Flight 20 O_3(ppb)
Thursday 11-4-76 8:56 → 10:40


Pasadena
44
36
40
Azusa
34
38
Los Angeles
San Bernardino
49
38
38
San Bernardino
50
Upland
32
Spiral 2
Bag 2
El Monte
W. Covina
Pomona
18
San Bernardino
Riverside
39
26
Bag 1
Spiral 1
49
Riverside
30
Fullerton
Corona
Spiral 3
40
31
30
47
42
46
Anaheim
Riverside
Orange
Los Angeles
Orange

Each bag filled during 2 passes - 100ft above the airport runways

Flight 20 Thursday 11-4-76

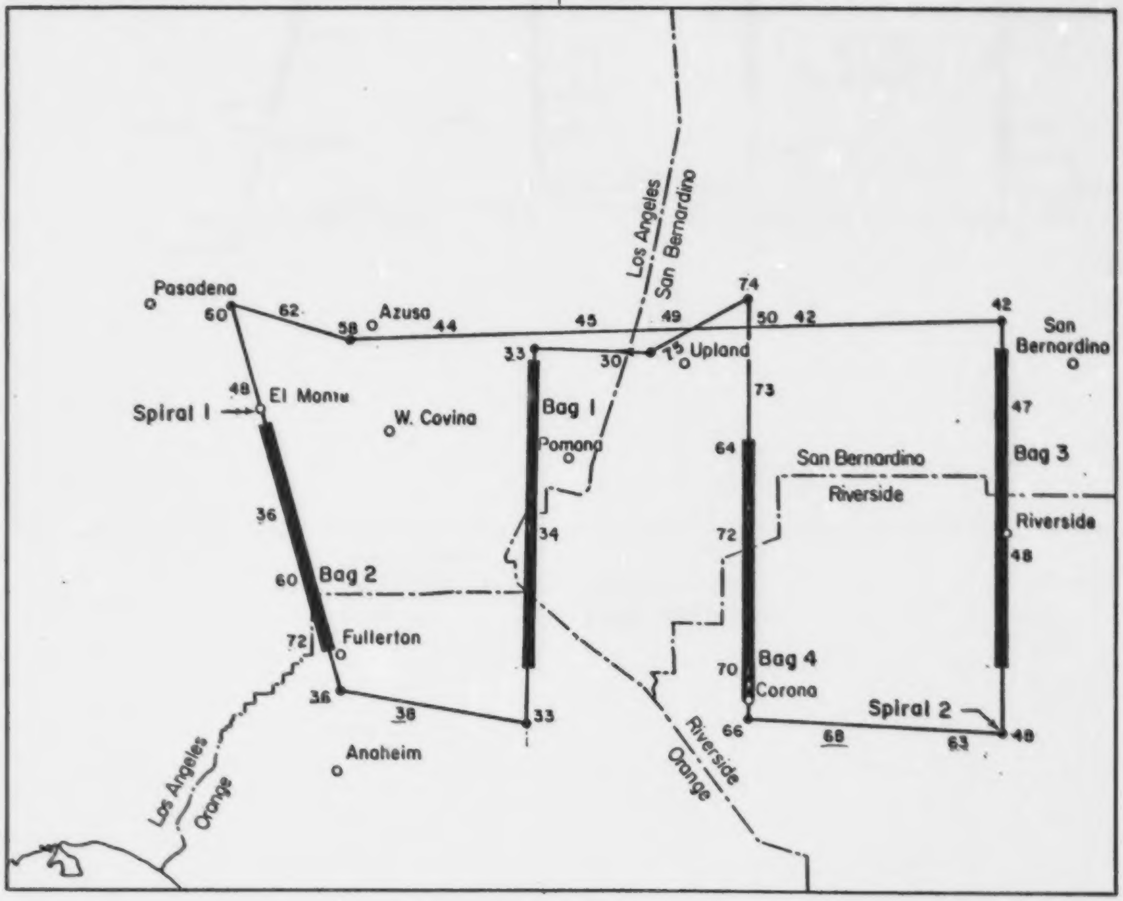
NO_x/NO(ppb) 8:56 → 10:40


Los Angeles
San Bernardino
Pasadena
20/16
24/5
Azusa
58/32
27/12
80/38
27/11
12/7
30/14
10/6
8/6
18/6
15/4
San Bernardino
40/12
Upland
40/10
14/6
Spiral 2
Bag 2
El Monte
40/18
W. Covina
Pomona
30/10
San Bernardino
Riverside
40/10
Riverside
12/5
Bag 1
Spiral 1
17/14
55/20
6/2
14/4
18/7
Fullerton
30/7
Corona
Spiral 3
10/4
13/5
20/6
30/10
12/6
Anaheim
Riverside
Orange
Los Angeles
Orange

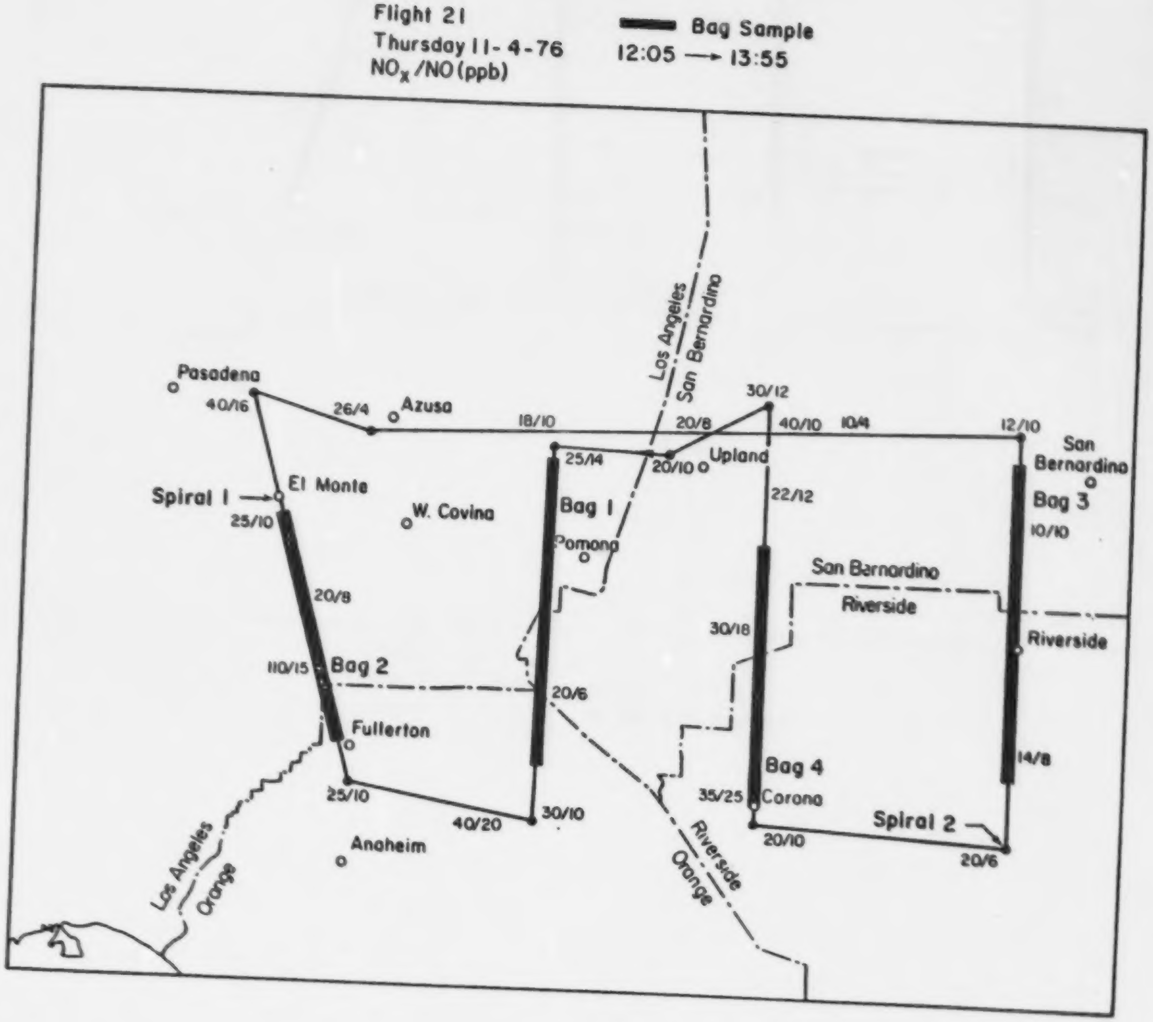
Each bag filled during 2 passes - 100 ft above the airport runways

Flight 21
Thursday 11-4-76
O_3 (ppb)

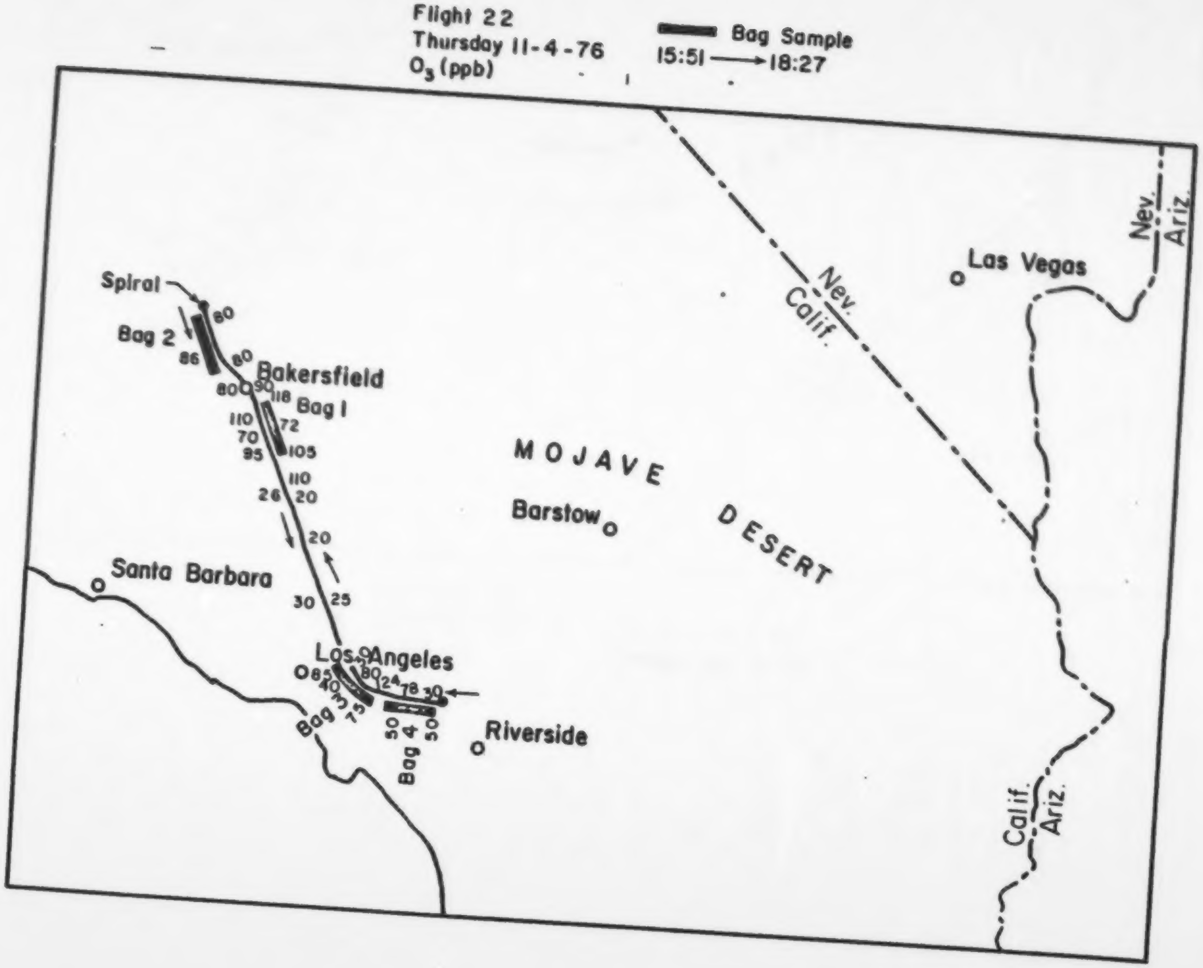
▬ Bag Sample
12:05 → 13:55


Pasadena
60
62
58
Azusa
44
45
49
74
50
42
42
San Bernardino
33
30
75
Upland
Los Angeles
San Bernardino
48
Spiral 1
El Monte
W. Covina
Bag 1
Pomona
73
47
64
San Bernardino
Bag 3
Riverside
36
34
72
Riverside
48
60
Bag 2
72
Fullerton
70
Bag 4
Corona
36
38
33
Spiral 2
66
68
63
48
Anaheim
Riverside
Orange
Los Angeles
Orange

Flight 21
Thursday 11-4-76
NO_x/NO (ppb)

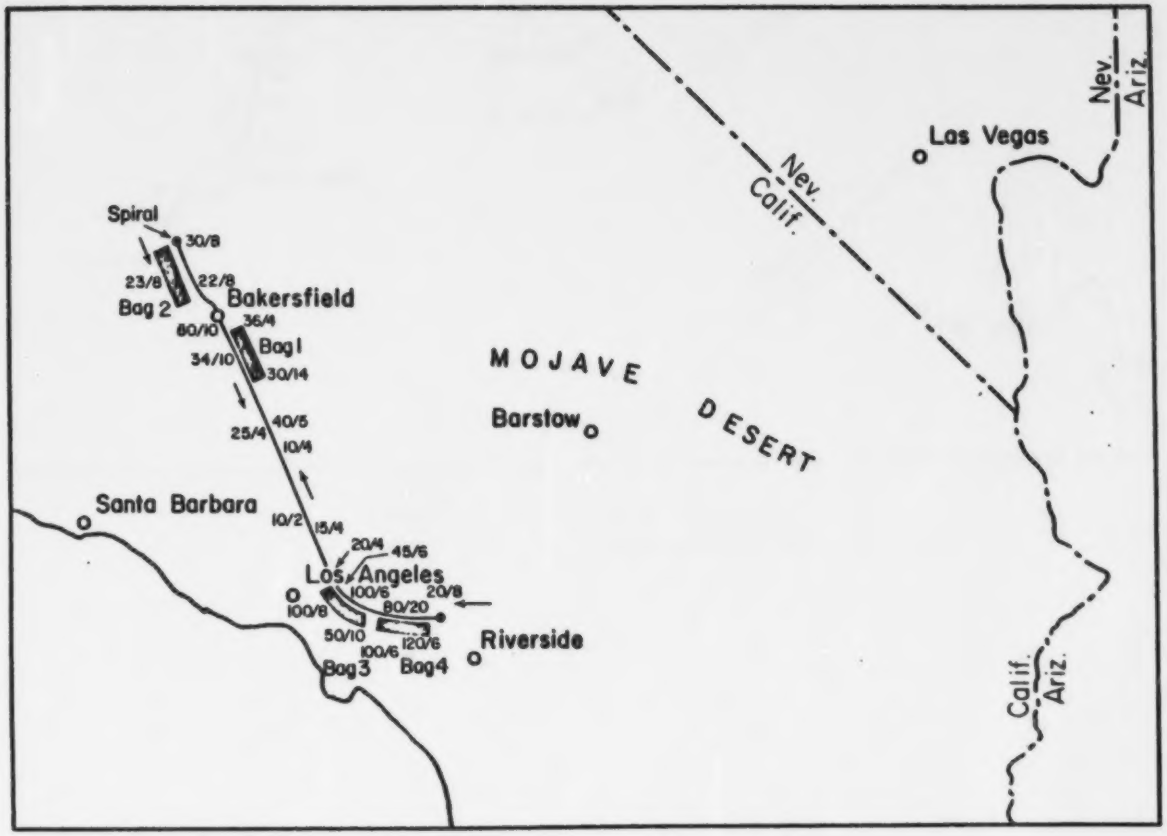

Bag Sample
12:05 → 13:55
Pasadena
40/16
26/4
Azusa
18/10
Los Angeles
San Bernardino
30/12
20/8
40/10
10/4
12/10
San Bernardino
25/14
20/10
Upland
Spiral 1
El Monte
25/10
W. Covina
Bag 1
Pomona
22/12
Bag 3
10/10
20/8
San Bernardino
Riverside
30/18
Riverside
110/15
Bag 2
20/6
Fullerton
Bag 4
14/8
35/25
Corona
25/10
40/20
30/10
Spiral 2
20/10
20/6
Anaheim
Riverside
Orange
Los Angeles
Orange

Flight 22
Thursday 11-4-76
O_3 (ppb)


Bag Sample
15:51 → 18:27
Spiral
Bag 2
86
80
80
Bakersfield
80
90
118
Bag 1
110
70
95
72
105
110
26
20
20
30
25
Santa Barbara
Los Angeles
85
40
Bag 3
75
80
24
78
30
50
Bag 4
50
Riverside
MOJAVE DESERT
Barstow
Nev.
Calif.
Las Vegas
Nev.
Ariz.
Calif.
Ariz.

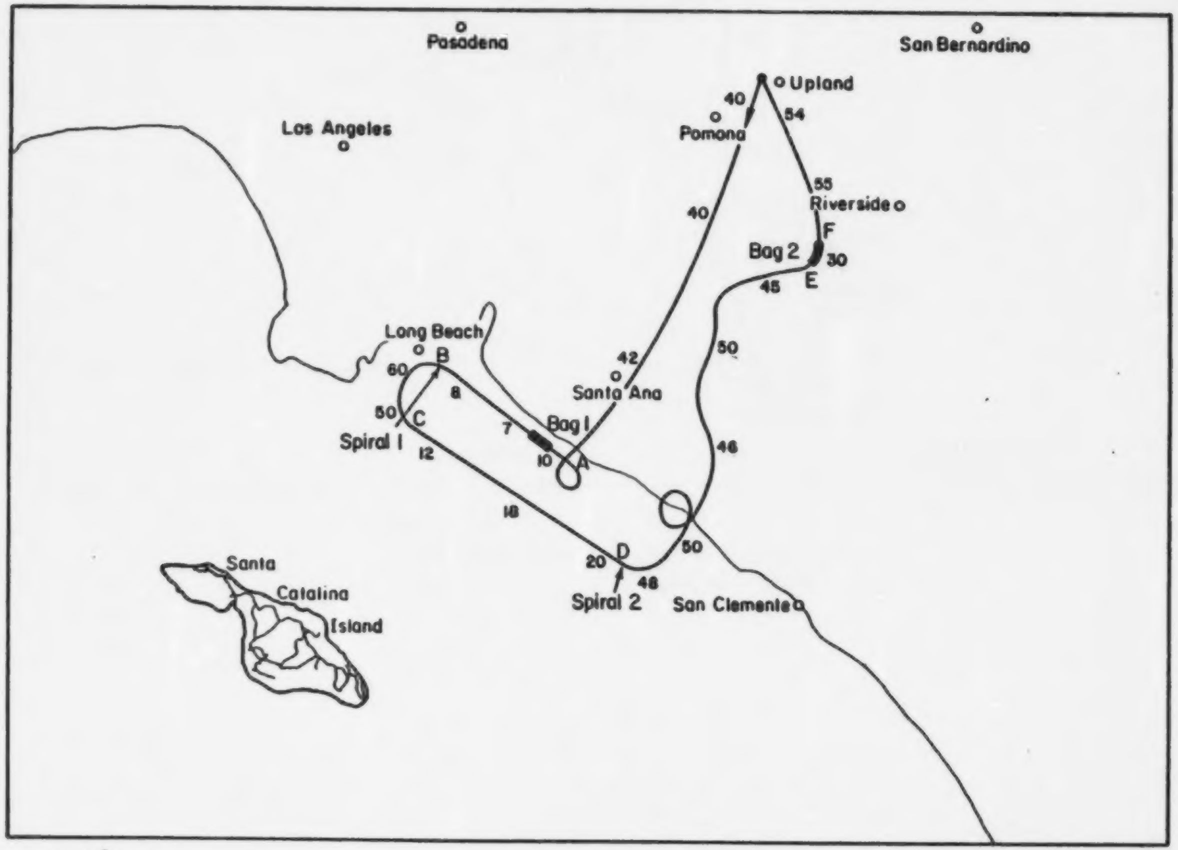
Flight 22
Thursday 11-4-76
NO_x/NO (ppb)

▬ Bag Sample
15:51 ⟶ 18:27


Spiral
30/8
23/8
22/8
Bag 2
Bakersfield
36/4
80/10
Bag 1
34/10
30/14
25/4
40/5
10/4
Santa Barbara
10/2
15/4
20/4
45/5
Los Angeles
100/6
20/8
100/8
80/20
50/10
120/6
100/6
Bag 3
Bag 4
Riverside
MOJAVE DESERT
Barstow
Nev.
Calif.
Las Vegas
Nev.
Ariz.
Calif.
Ariz.

Flight 23
Friday 11-5-76
O_3 (ppb)

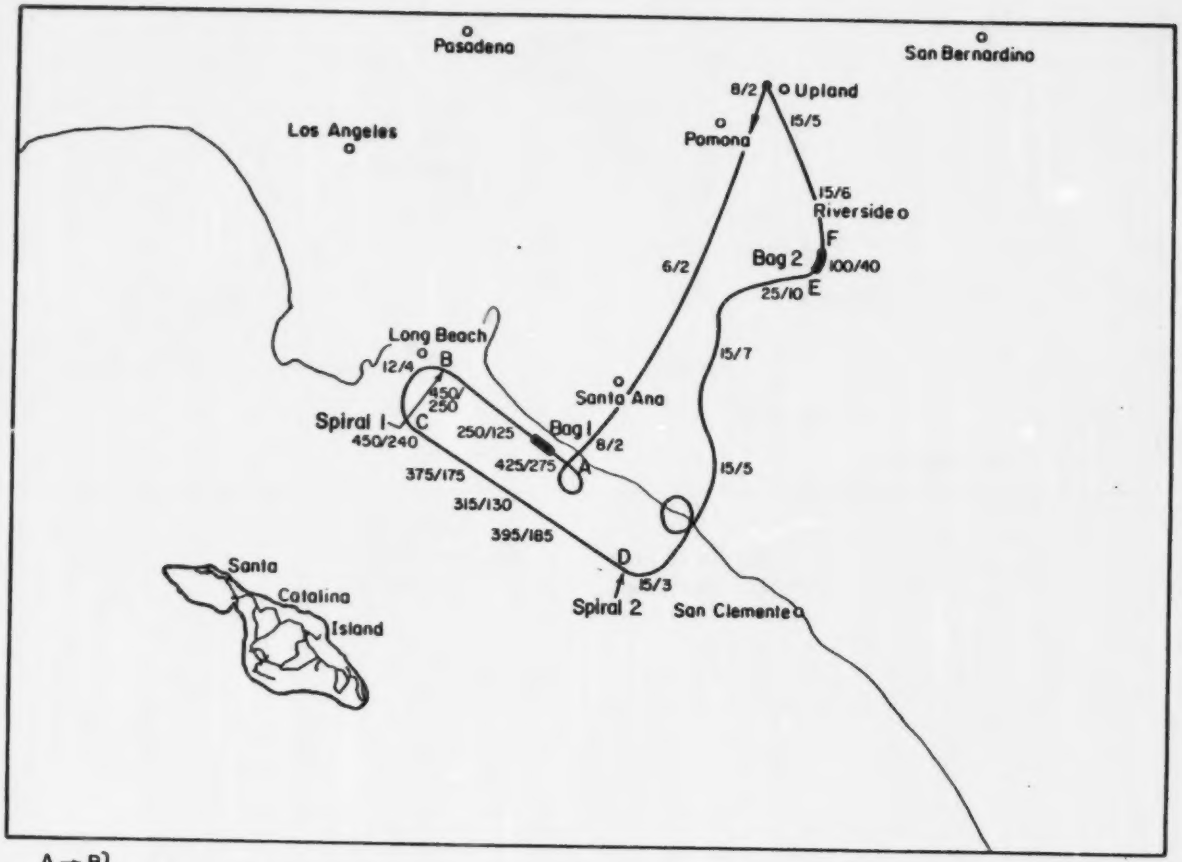
▬ Bag Sample
8:55 ⟶ 10:13


Pasadena
San Bernardino
Los Angeles
Upland
Pomona
40
54
55
Riverside
F
Bag 2
30
E
45
40
50
Long Beach
B
60
8
42
Santa Ana
50
C
Spiral 1
7
Bag 1
12
10
A
46
18
D
50
20
48
Spiral 2
San Clemente
Santa
Catalina
Island

A → B }
C → D } 100 ft. above water

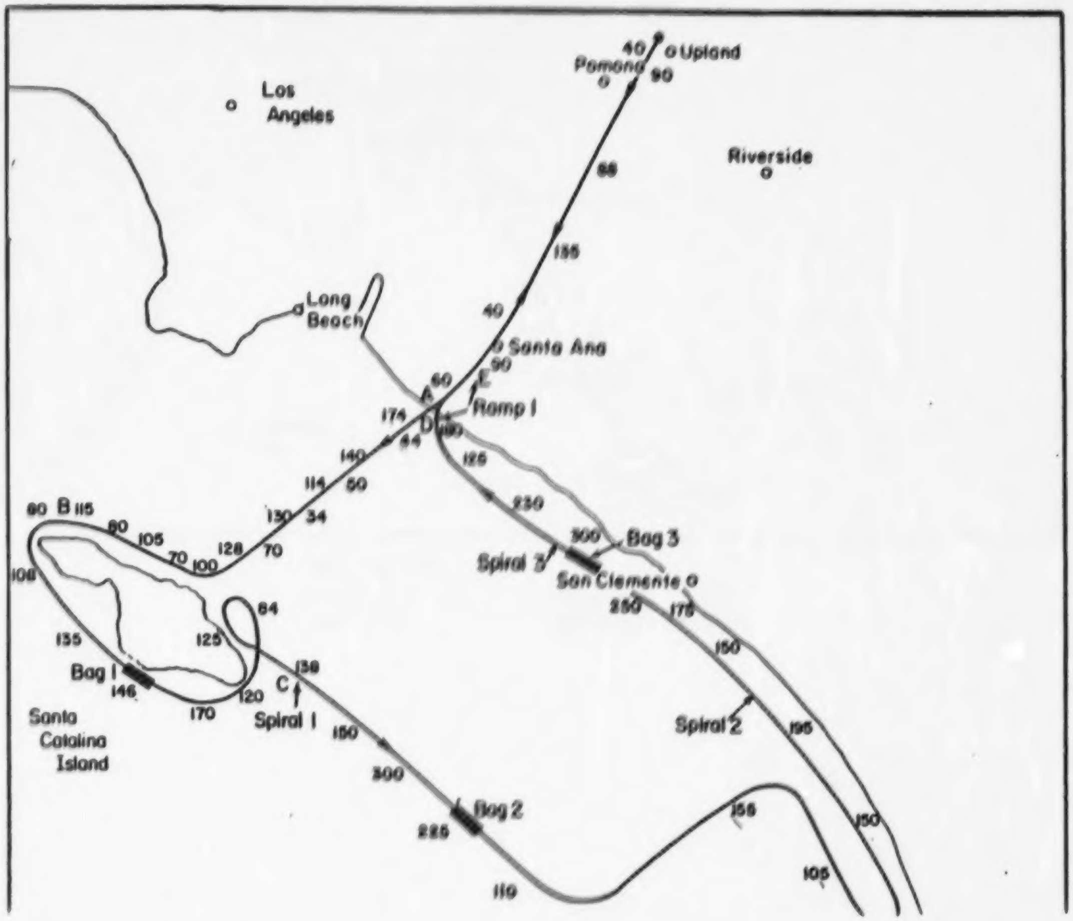
Flight 23
Friday 11-5-76
NO_x/NO(ppb)

▬ Bag Sample
8:55 ⟶ 10:13


Pasadena
San Bernardino
Los Angeles
8/2
Upland
Pomona
15/5
15/6
Riverside
F
Bag 2
100/40
6/2
25/10
E
Long Beach
12/4
B
450/250
15/7
Santa Ana
Spiral 1
C
450/240
250/125
Bag 1
8/2
425/275
A
15/5
375/175
315/130
395/185
D
15/3
Spiral 2
San Clemente
Santa Catalina Island

A → B } 100 ft. above water
C → D }
E → F - 50 ft. above runway to fill bag

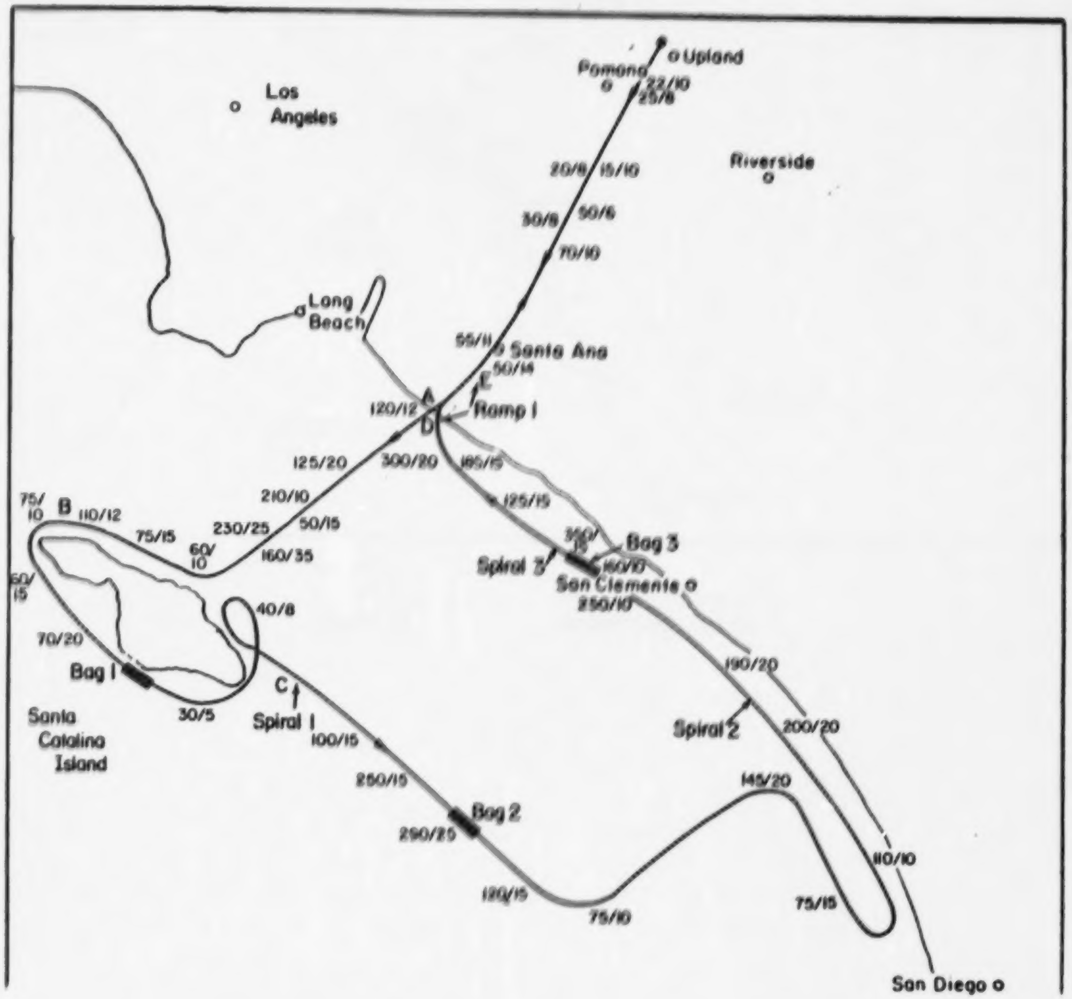
Flight 24
Friday 11-5-76
O_3 (ppb)



▬ Bag Sample
12:15 ⟶ 14:37
Los Angeles
Long Beach
Pomona
Upland
Riverside
Santa Ana
San Clemente
Santa Catalina Island
Ramp I
Spiral 1
Spiral 2
Spiral 3
Bag 1
Bag 2
Bag 3
A
B
C
D
E
40
90
88
135
40
90
60
174
64
140
50
114
34
130
70
128
100
70
105
90
90
115
108
135
146
170
120
125
84
138
150
300
225
110
156
105
150
195
150
175
250
300
230
125
180

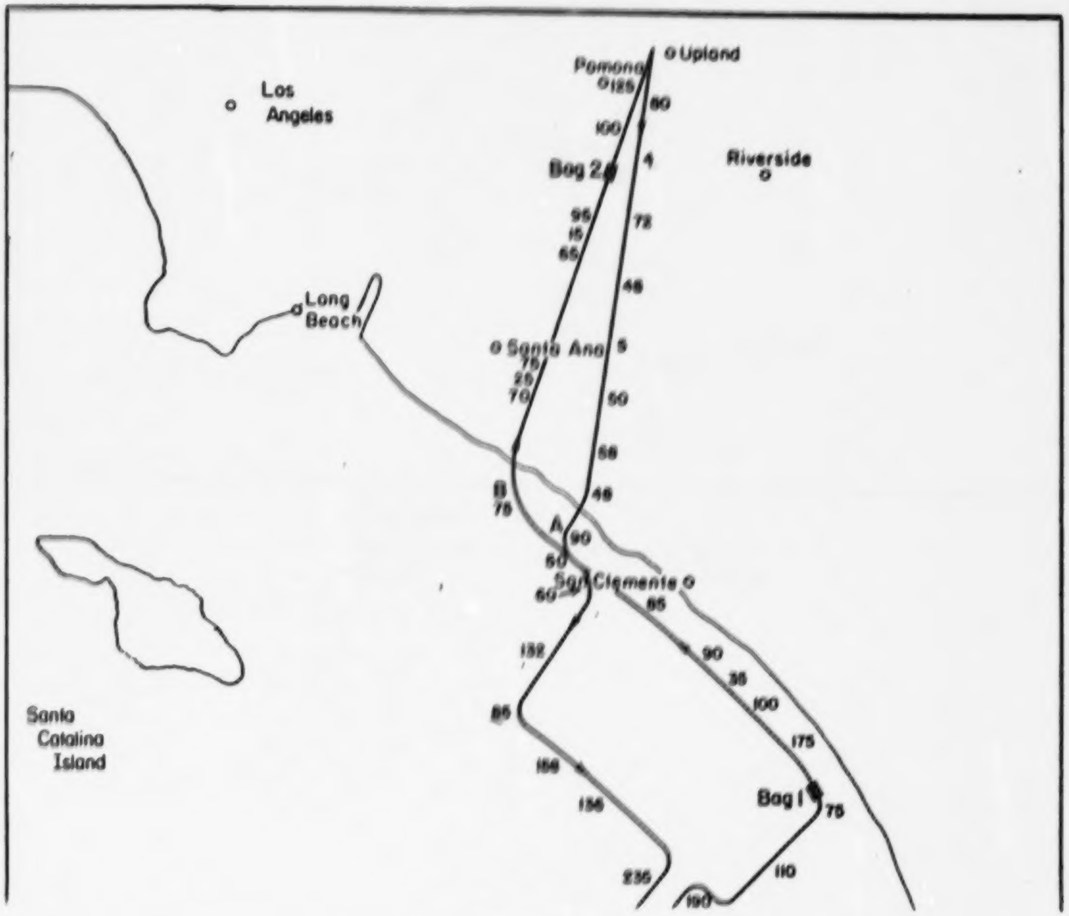
Flight 24
Friday 11-5-76
NO_x/NO(ppb)

Bag Sample
12:15 ⟶ 14:37


Los Angeles
Pomona
Upland
Riverside
22/10
25/8
20/8
15/10
30/8
50/6
70/10
Long Beach
55/11
Santa Ana
50/14
E
A
Ramp I
120/12
D
125/20
300/20
185/15
210/10
125/15
75/10
B
110/12
75/15
230/25
50/15
60/10
160/35
350/15
Bag 3
Spiral 3
160/10
San Clemente
250/10
60/15
40/8
70/20
Bag I
C
Spiral I
30/5
Santa Catalina Island
100/15
190/20
Spiral 2
200/20
250/15
145/20
Bag 2
290/25
110/10
120/15
75/10
75/15
San Diego

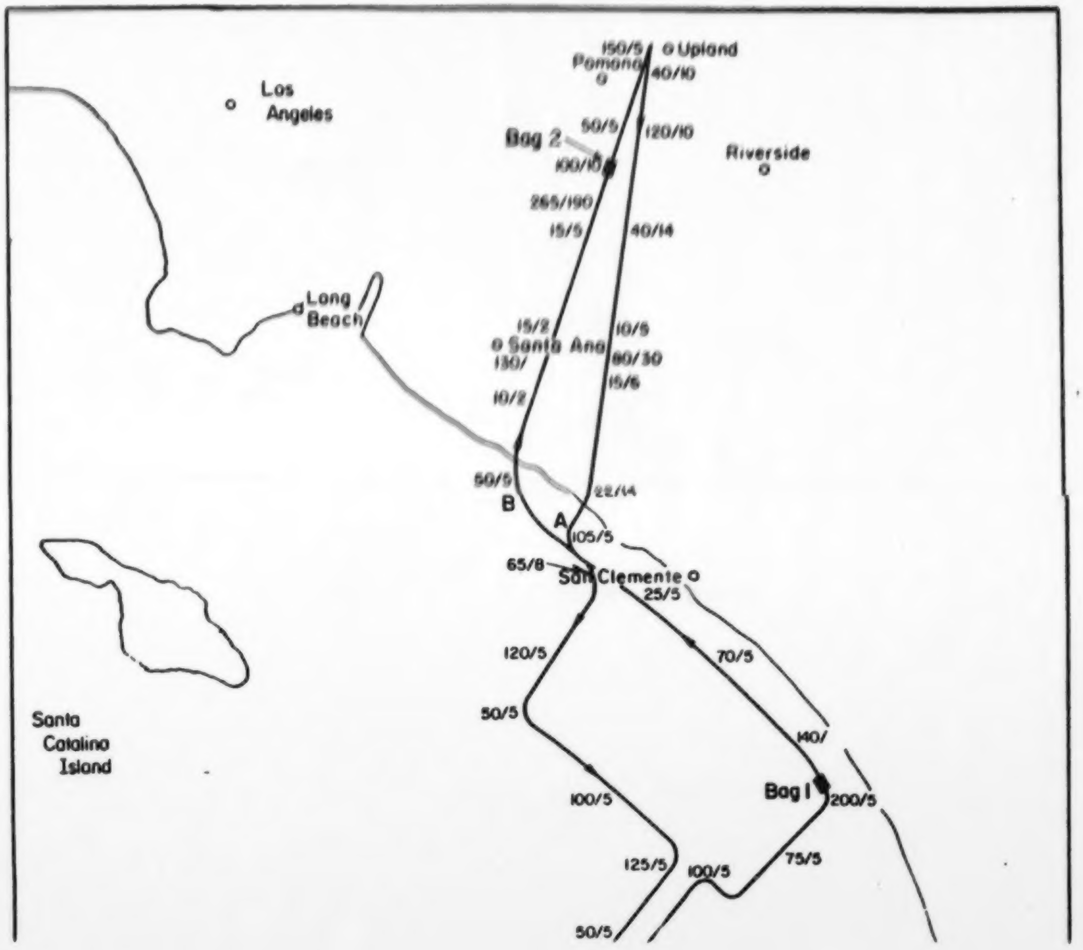
Flight 25
Friday 11-5-76
O_3 (ppb)

▬ Bag Sample
16:29 ⟶ 18:07


o Upland
Pomona
o125
80
100
Bag 2
4
Riverside
o
Los
Angeles
95
15
65
72
46
o Long
Beach
o Santa Ana
75
25
70
5
50
58
B
75
48
A
90
50
San Clemente o
60
65
132
90
35
100
85
175
Santa
Catalina
Island
166
156
Bag 1
75
235
110
190

Flight 25
Friday 11-5-76
NO_x/NO (ppb)

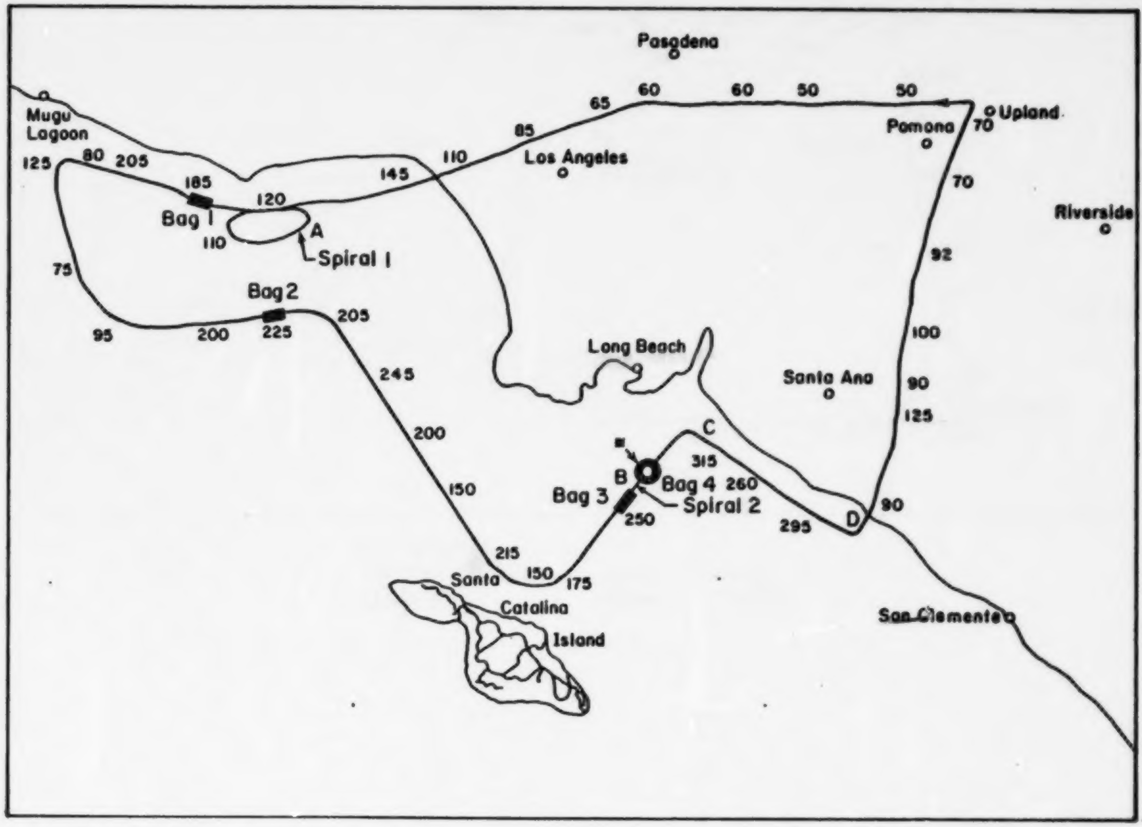
▬ Bag Sample
16:29 → 18:07



150/5
o Upland
Pomona
o
40/10
o Los Angeles
50/5
120/10
Bag 2
100/10
Riverside o
265/190
15/5
40/14
o Long Beach
15/2
o Santa Ana
130/
10/5
80/30
15/6
10/2
50/5
B
22/14
A
105/5
65/8
San Clemente o
25/5
120/5
70/5
50/5
140/
Santa Catalina Island
Bag 1
200/5
100/5
75/5
125/5
100/5
50/5

Flight 26
Thursday 11-8-76
O_3 (ppb)

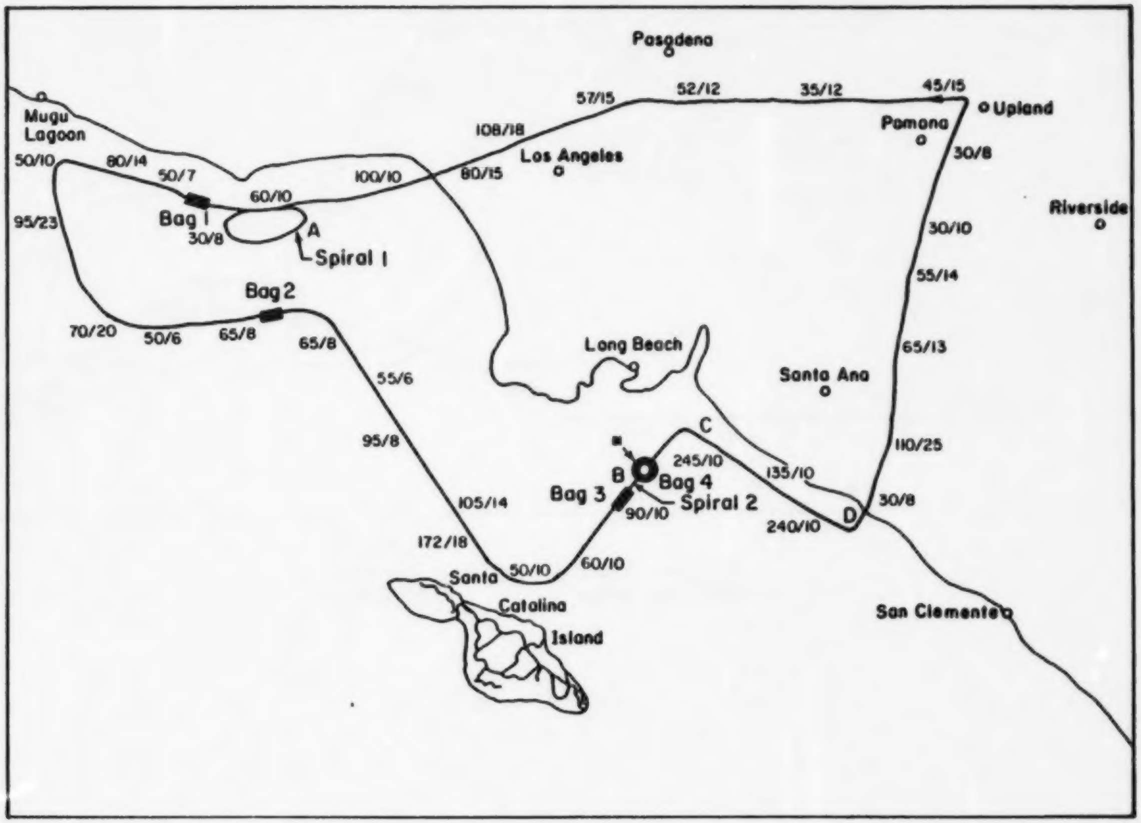
▬ Bag Sample
11:53 ⟶ 14:12


Pasadena
Mugu Lagoon
Los Angeles
Long Beach
Santa Ana
Pomona
Upland
Riverside
San Clemente
Santa Catalina Island
Bag 1
Bag 2
Bag 3
Bag 4
Spiral 1
Spiral 2
A
B
C
D
125
80
205
185
120
110
75
95
200
225
205
245
200
150
215
150
175
250
315
260
295
90
145
110
85
65
60
60
50
50
70
70
92
100
90
125

A→B = Flying 100 ft above water
▪ = Circling at 400 ft to fill bag 4
C→D = Flying 200 ft above water

Flight 26
Thursday 11-8-76
NO_x / NO (ppb)

▬ Bag Sample
11:53 ⟶ 14:12

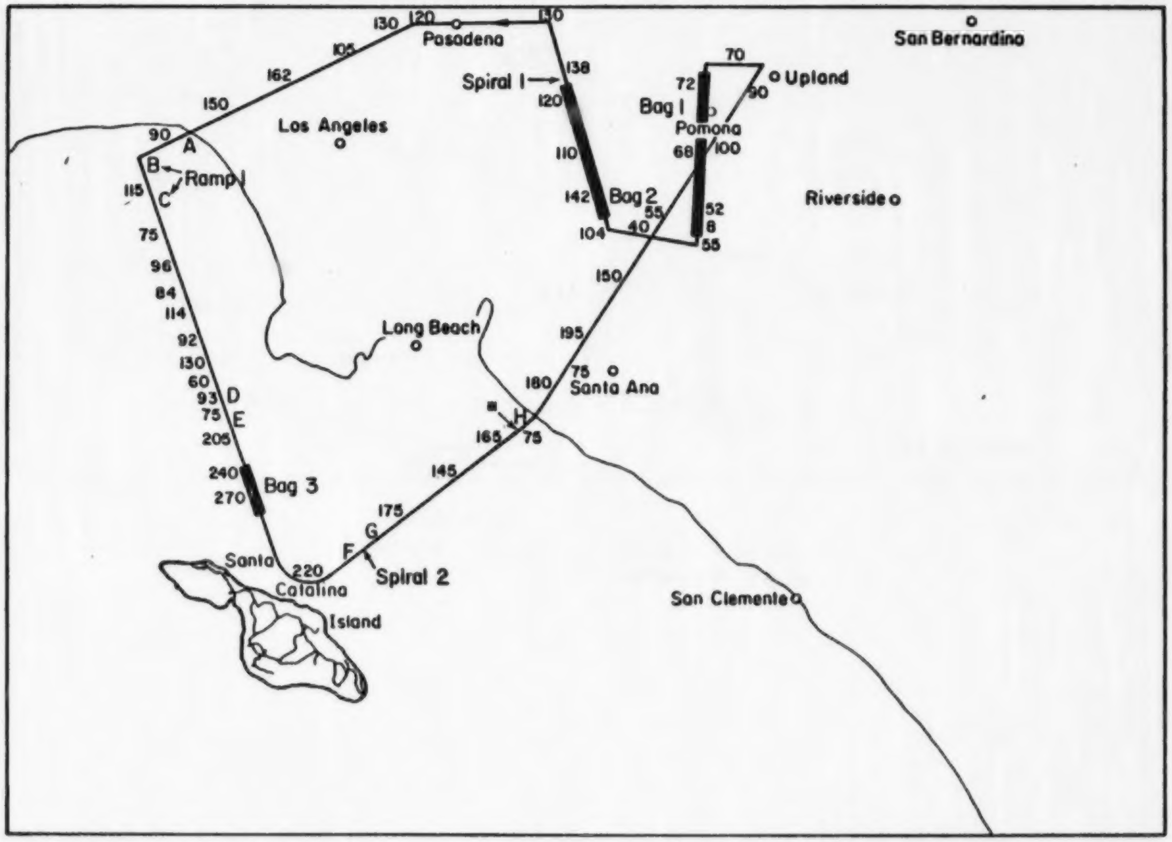


Pasadena
Mugu Lagoon
Los Angeles
Upland
Pomona
Riverside
Long Beach
Santa Ana
San Clemente
Santa Catalina Island
Bag 1
Bag 2
Bag 3
Bag 4
A
B
C
D
Spiral 1
Spiral 2
50/10
80/14
50/7
60/10
100/10
80/15
108/18
57/15
52/12
35/12
45/15
30/8
30/10
55/14
65/13
110/25
30/8
135/10
245/10
240/10
90/10
60/10
50/10
172/18
105/14
95/8
55/6
65/8
65/8
50/6
70/20
95/23
30/8

A → B = Flying 100 ft above water
▪ = Circling at 400 ft to fill bag 4
C → D = Flying 200 ft above water

Flight 27
Monday 11-8-76
O_3 (ppb)

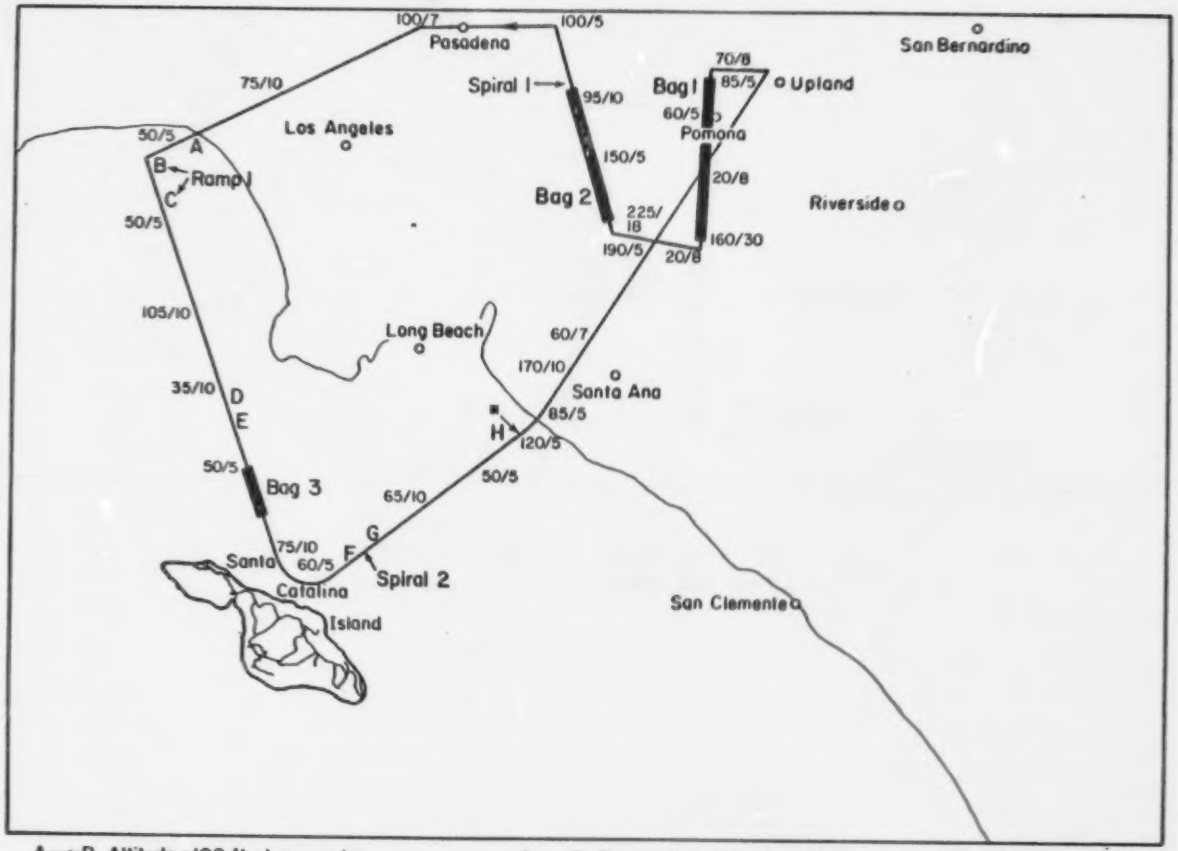
▬ Bag Sample
16:05 → 18:06


Pasadena
Los Angeles
Long Beach
Santa Ana
Pomona
Upland
San Bernardino
Riverside
San Clemente
Santa Catalina Island
Spiral 1
Spiral 2
Bag 1
Bag 2
Bag 3
Ramp I
A
B
C
D
E
F
G
H
120
130
105
162
150
90
115
75
96
84
114
92
130
60
93
75
205
240
270
220
175
145
165
75
180
75
195
150
40
55
104
142
110
120
138
130
72
70
90
68
100
52
8
55

A → B Altitude = 100 ft. above water
B → C Increasing altitude to 1000 ft.-Ramp I
D → E Decreasing altitude to 500 ft.
E → F Altitude = 500 ft.
▪ - Oil Rig

Flight 27
Monday 11-8-76
NO_x/NO (ppb)

▬ Bag Sample
16:05 ⟶ 18:06


100/7
Pasadena
100/5
75/10
Spiral 1
95/10
Bag 1
70/8
85/5
Upland
San Bernardino
60/5
Pomona
Los Angeles
50/5
A
B
Ramp I
C
150/5
Bag 2
20/8
225/18
190/5
20/8
160/30
Riverside
50/5
105/10
Long Beach
60/7
170/10
Santa Ana
35/10
D
E
H
85/5
120/5
50/5
Bag 3
65/10
G
75/10
60/5
F
Spiral 2
Santa Catalina Island
San Clemente

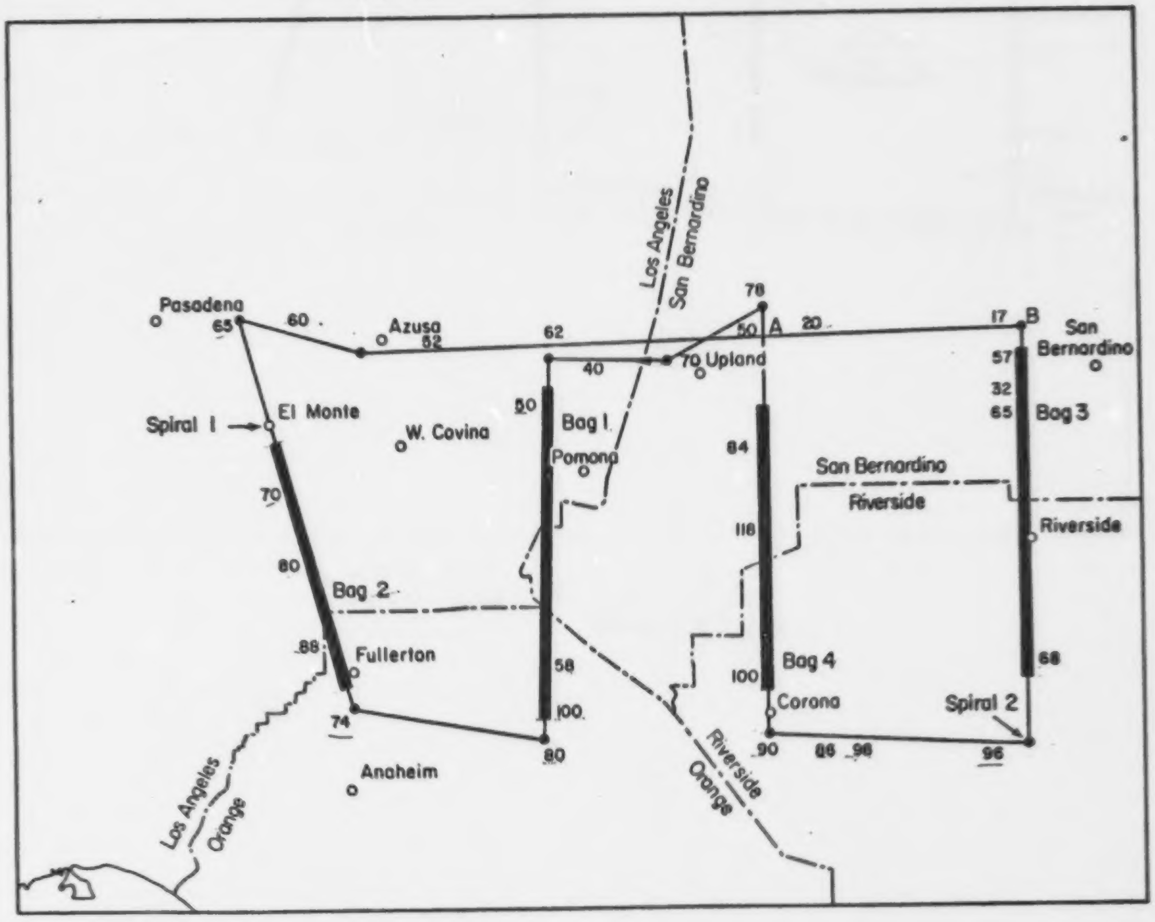
A ⟶ B Altitude = 100 ft. above water
B ⟶ C Increasing altitude to 1000 ft. - Ramp I
C ⟶ D Altitude = 1000 ft.

D ⟶ E Decreasing altitude to 500 ft.
E ⟶ F Altitude = 500 ft.
G ⟶ H Altitude = 250 ft.

▪ - Oil Rig

Flight 28
Tuesday 11-9-76
O_3 (ppb)

▬ Bag Sample
9:15 ⟶ 11:10

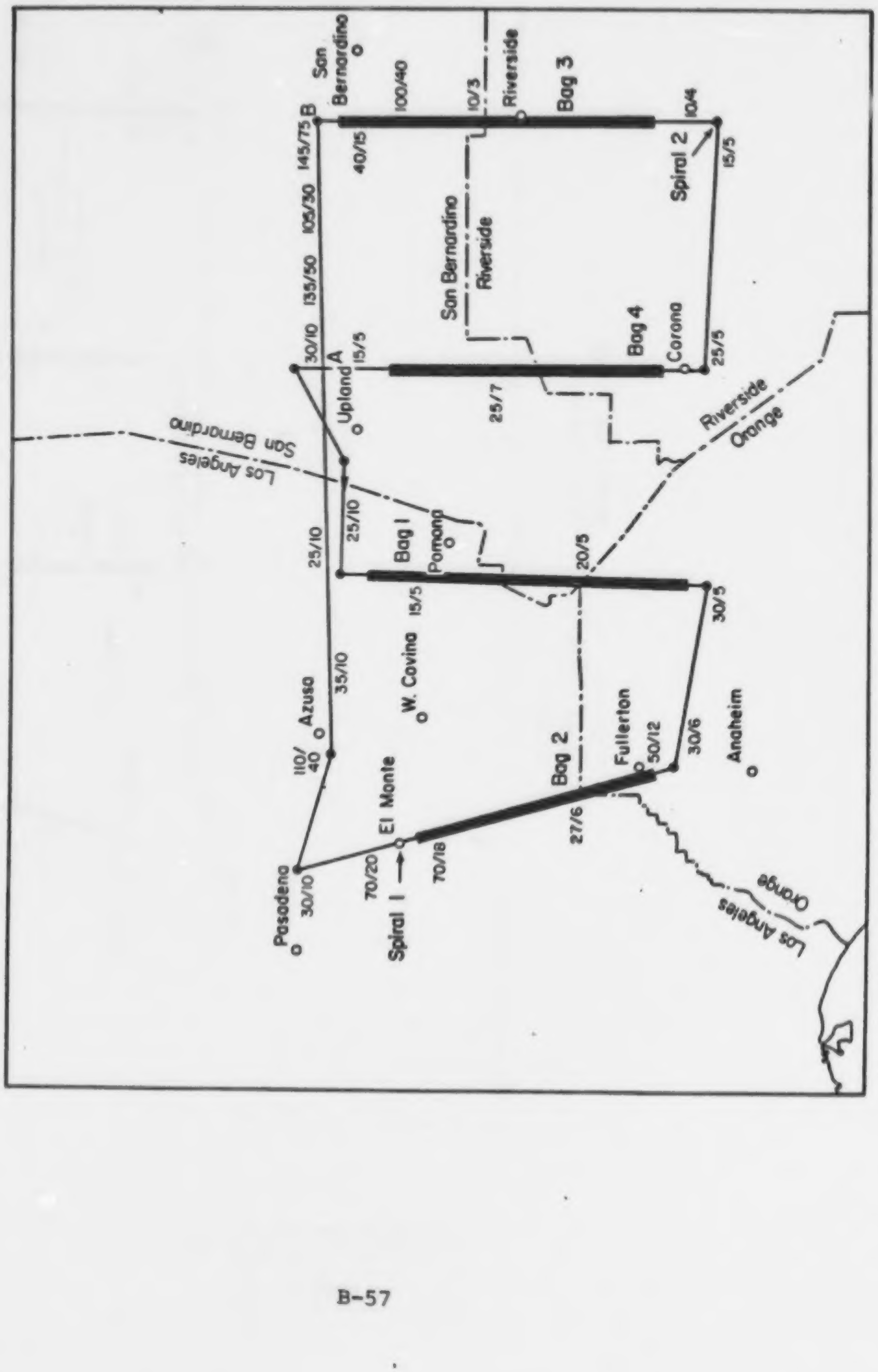


Pasadena
65
60
Azusa
52
62
40
70 Upland
78
50
A
20
17
B
San Bernardino
57
32
65
Bag 3
Spiral 1
El Monte
W. Covina
50
Bag 1
Pomona
Los Angeles
San Bernardino
84
118
100
Bag 4
Corona
San Bernardino
Riverside
Riverside
68
70
80
Bag 2
88
Fullerton
74
58
100
80
Anaheim
Los Angeles
Orange
Riverside
Orange
90
86
98
Spiral 2
96

A ⟶ B 500 ft. above ground

Flight 28
Tuesday 11-9-76
NO_x/NO (ppb)

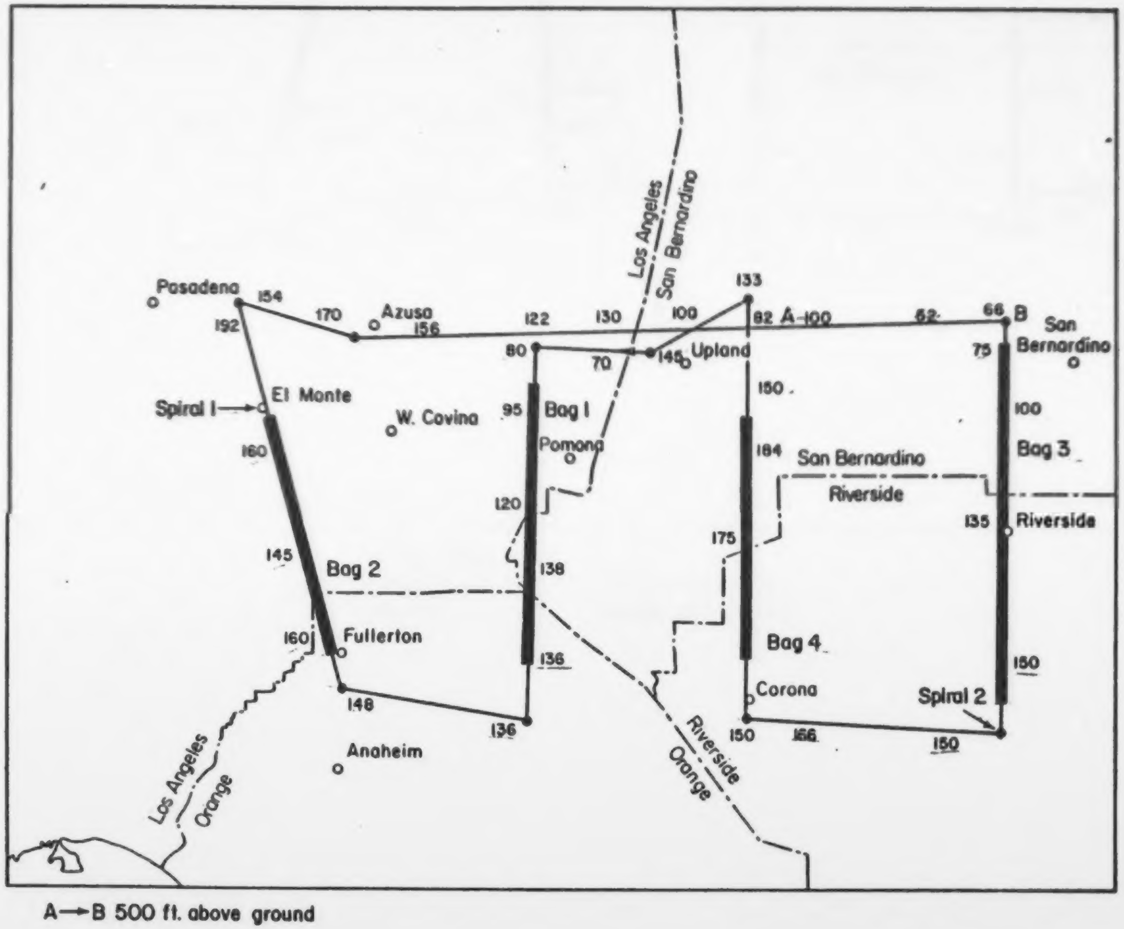
▬ Bag Sample
9:15 ⟶ 11:10


Pasadena
30/10
Spiral 1 ⟶
70/20
70/18
El Monte
110/40
Azusa
35/10
W. Covina
15/5
25/10
Bag 1
Pomona
25/10
Upland
30/10
A
15/5
135/50
105/30
145/75
B
San Bernardino
40/15
100/40
10/3
Riverside
Bag 3
10/4
Spiral 2
15/5
San Bernardino
Riverside
Bag 4
Corona
25/5
25/7
20/5
30/5
Bag 2
27/6
Fullerton
50/12
30/6
Anaheim
Los Angeles
San Bernardino
Riverside
Orange
Los Angeles
Orange

A ⟶ B 500 ft. above ground

Flight 29
Tuesday 11-9-76
O_3 (ppb)

▬ Bag Sample
12:17 → 13:59

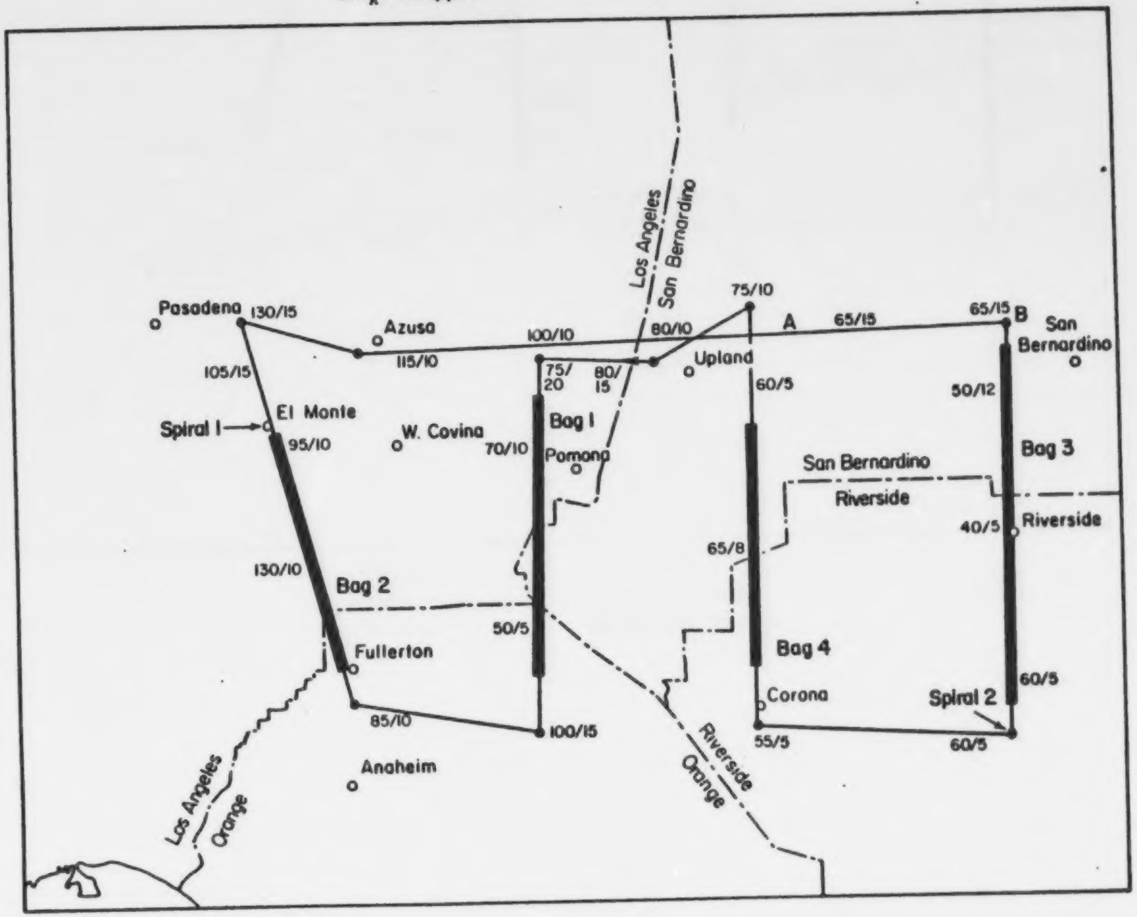


Pasadena
154
192
170
Azusa
156
122
130
100
133
82
A-100
62
66
B
San Bernardino
Los Angeles
San Bernardino
80
70
148
Upland
75
Spiral I
El Monte
W. Covina
95
Bag I
Pomona
150
100
160
184
San Bernardino
Riverside
Bag 3
120
175
135
Riverside
145
Bag 2
138
160
Fullerton
136
Bag 4
150
Corona
Spiral 2
148
136
150
166
150
Anaheim
Riverside
Orange
Los Angeles
Orange

A→B 500 ft. above ground

Flight 29
Tuesday 11-9-76
NO_x/NO (ppb)

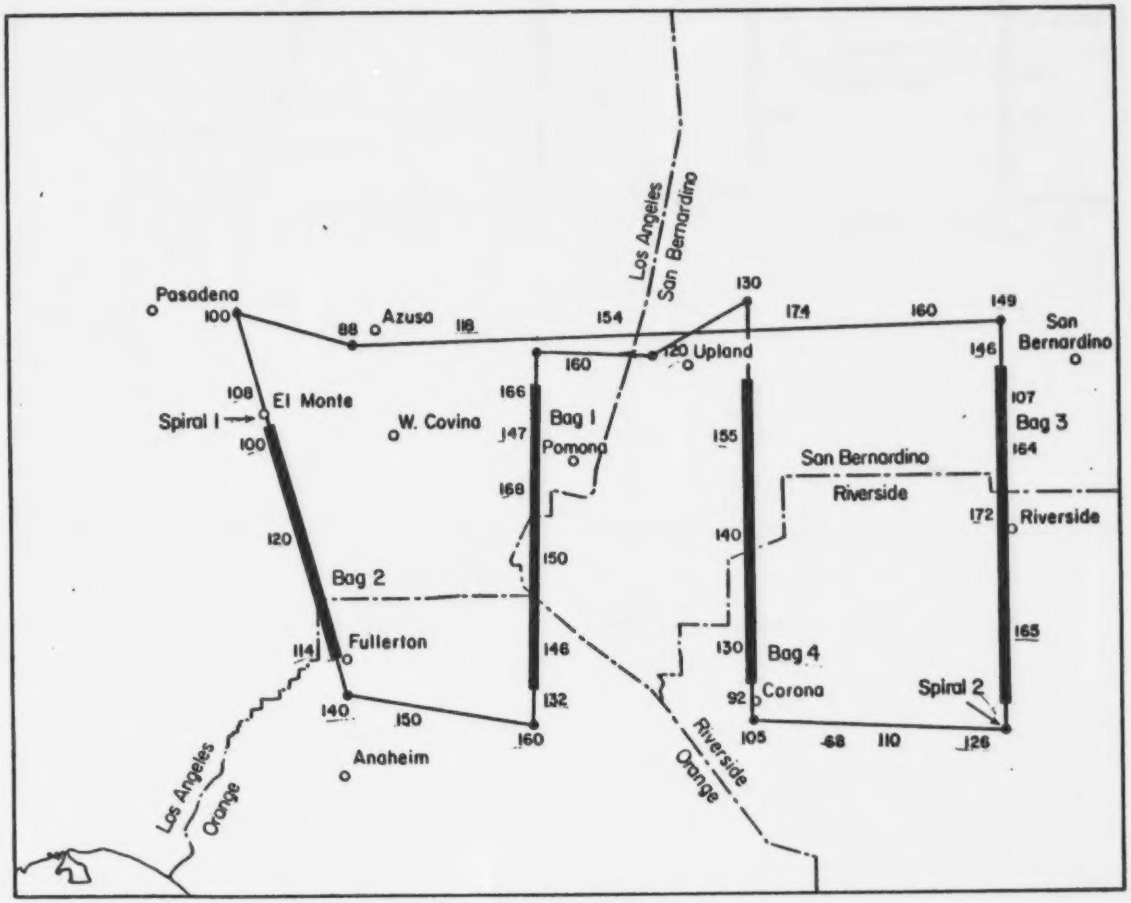
▬ Bag Sample
12:17 ⟶ 13:59


Pasadena
130/15
105/15
Spiral I
El Monte
95/10
Azusa
115/10
W. Covina
100/10
75/20
80/15
80/10
Bag I
70/10
Pomona
Los Angeles
San Bernardino
75/10
Upland
A
65/15
65/15
B
San Bernardino
60/5
50/12
Bag 3
San Bernardino
Riverside
40/5
Riverside
65/8
130/10
Bag 2
50/5
Fullerton
Bag 4
Corona
60/5
Spiral 2
85/10
100/15
55/5
60/5
Anaheim
Riverside
Orange
Los Angeles
Orange

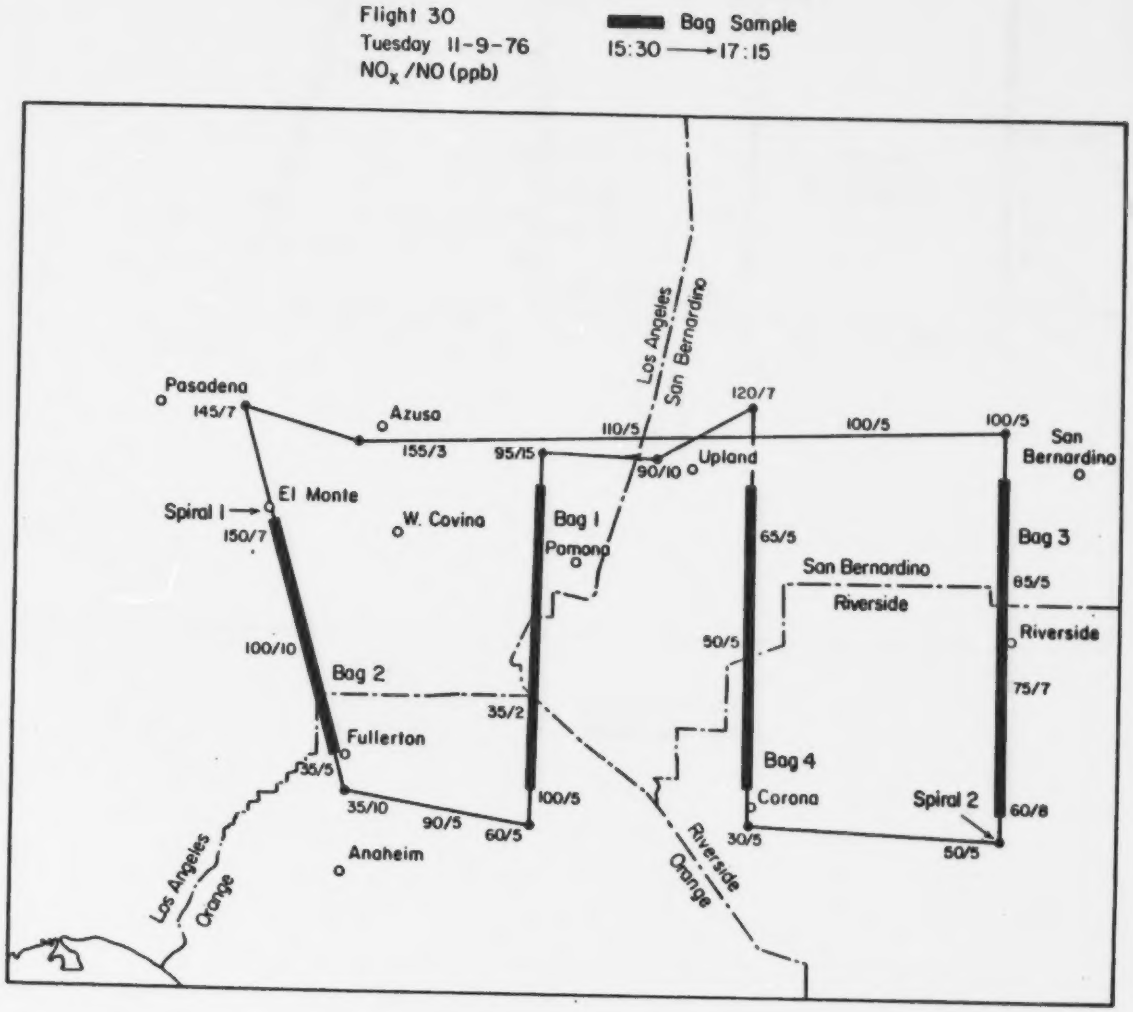
A ⟶ B 500 ft. above ground

Flight 30
Tuesday 11-9-76
O_3 (ppb)

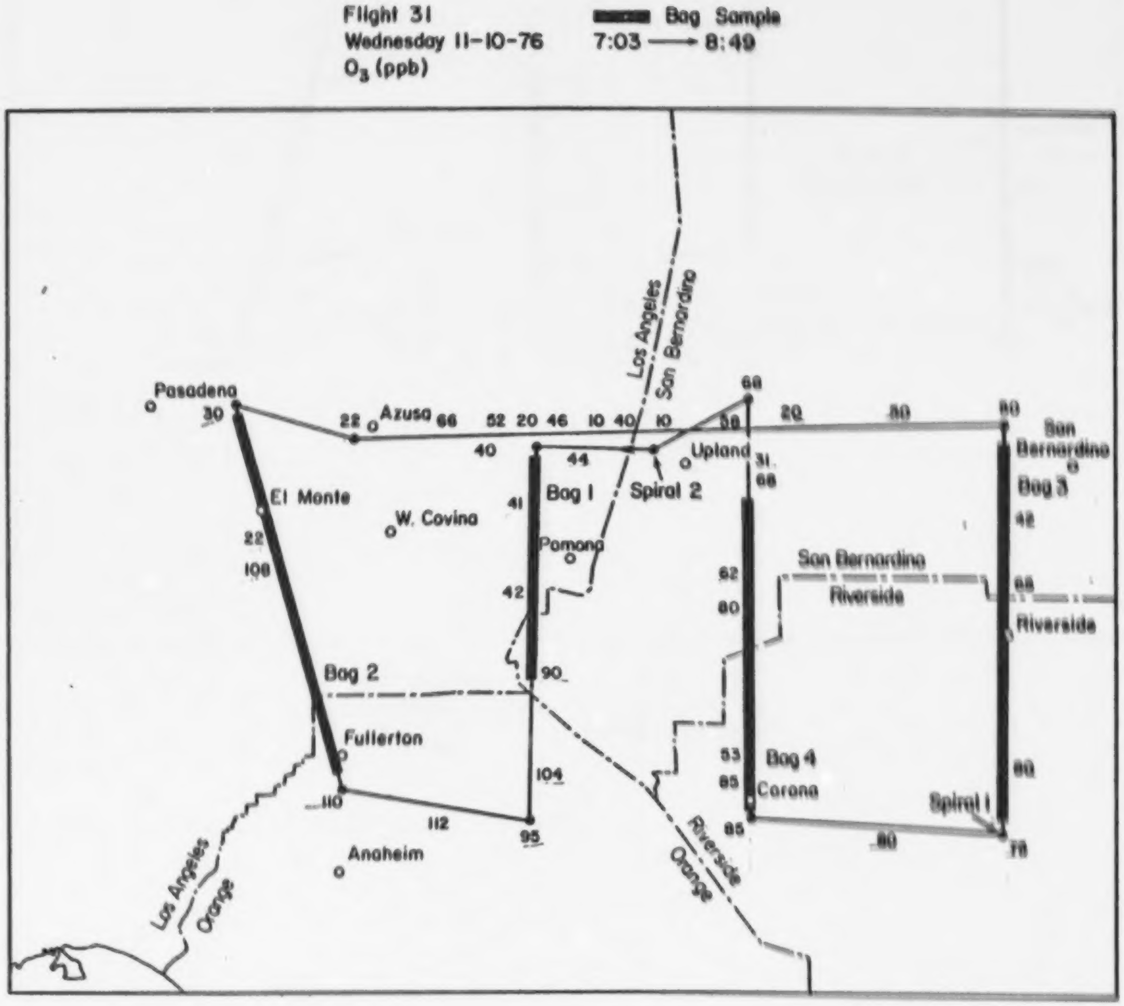
▬ Bag Sample
15:30 ⟶ 17:15


Pasadena
100
88
Azusa
118
154
Los Angeles
San Bernardino
130
174
160
149
San Bernardino
146
160
120 Upland
108
El Monte
Spiral I
100
W. Covina
166
Bag 1
147
Pomona
168
155
107
Bag 3
164
San Bernardino
Riverside
172
Riverside
120
Bag 2
150
140
114
Fullerton
146
130
Bag 4
165
92
Corona
Spiral 2
140
150
132
160
105
68
110
126
Anaheim
Riverside
Orange
Los Angeles
Orange

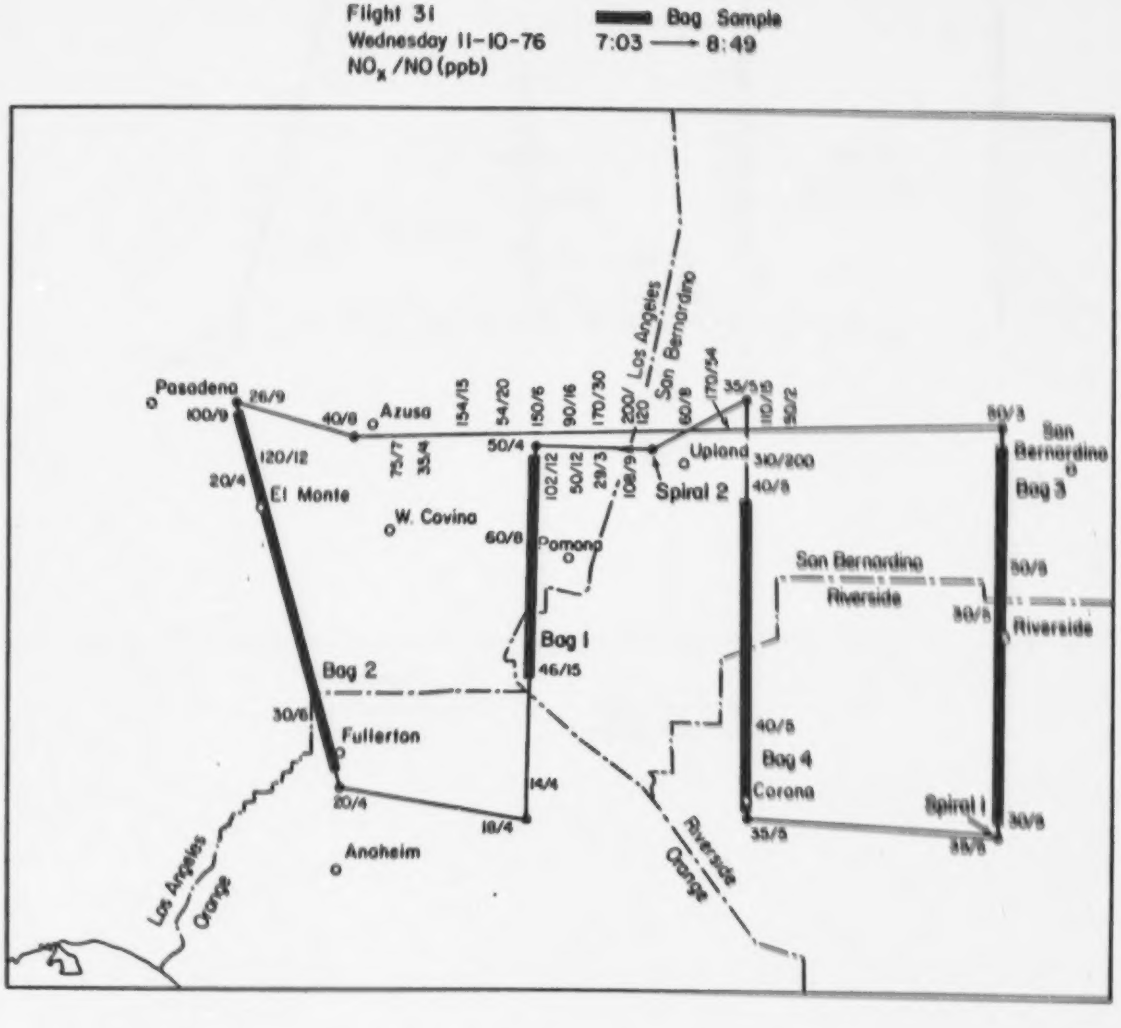
Flight 30
Tuesday 11-9-76
NO_x /NO (ppb)


Bag Sample
15:30 → 17:15
Pasadena
145/7
Azusa
155/3
95/15
110/5
Los Angeles
San Bernardino
120/7
100/5
100/5
San Bernardino
Upland
90/10
Spiral 1
El Monte
150/7
W. Covina
Bag 1
Pomona
65/5
Bag 3
San Bernardino
Riverside
85/5
Riverside
50/5
100/10
Bag 2
35/2
75/7
Fullerton
35/5
35/10
90/5
60/5
100/5
Bag 4
Corona
30/5
Spiral 2
50/5
60/8
Anaheim
Riverside
Orange
Los Angeles
Orange

Flight 31
Wednesday 11-10-76
O_3 (ppb)

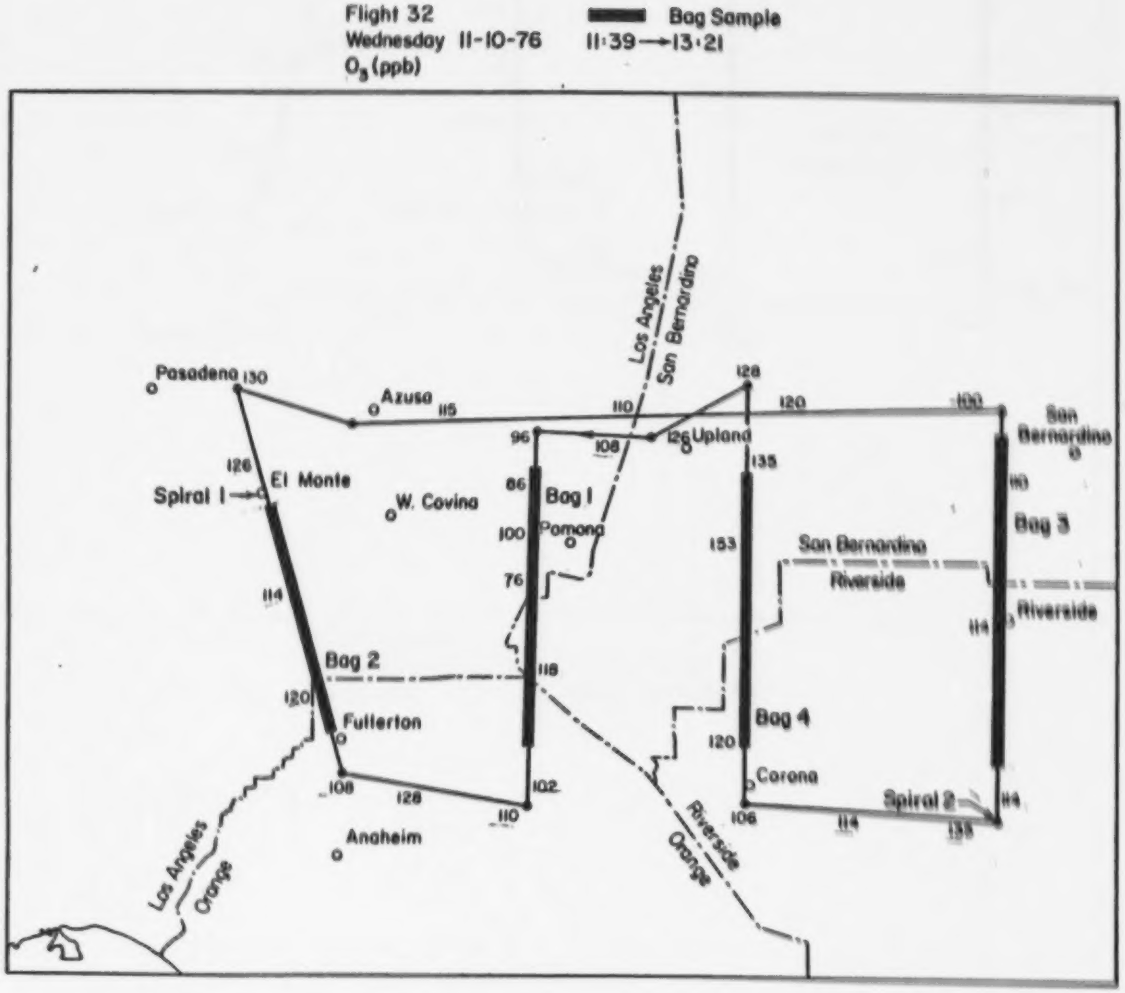

Bag Sample
7:03 → 8:49
Pasadena
30
22
Azusa
66
52
20
46
10
40
10
38
68
20
80
80
San Bernardino
Bag 3
42
68
Riverside
80
78
Spiral 1
80
85
Corona
85
53
Bag 4
60
62
31
68
Upland
Spiral 2
44
40
Bag 1
41
Pomona
42
90
104
95
112
110
Fullerton
Bag 2
El Monte
22
108
W. Covina
Anaheim
Los Angeles
San Bernardino
San Bernardino
Riverside
Riverside
Orange
Los Angeles
Orange

Flight 31
Wednesday 11-10-76
NO$_x$/NO (ppb)



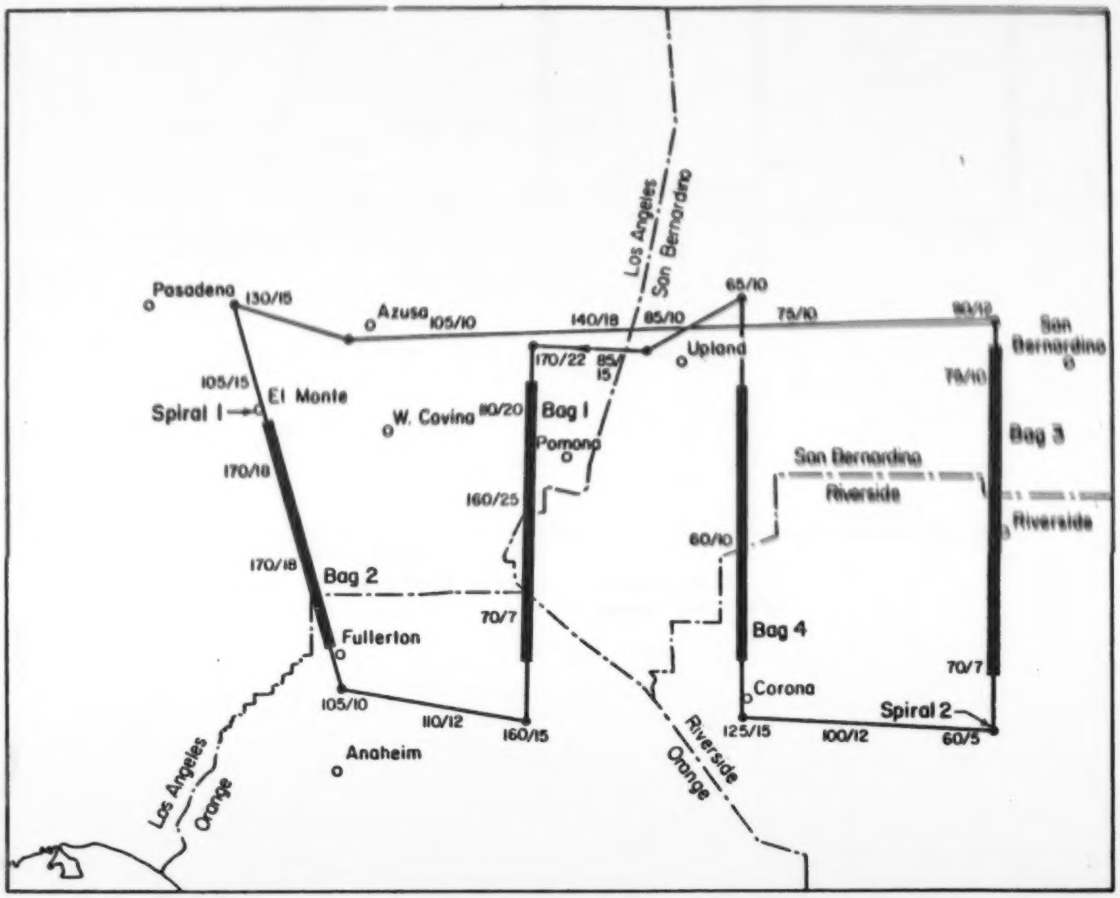
▬ Bag Sample
7:03 ⟶ 8:49
Pasadena
26/9
100/9
40/8
Azusa
154/15
54/20
150/6
90/16
170/30
200/
120
Los Angeles
San Bernardino
60/8
170/54
35/5
110/15
50/2
80/3
San Bernardino
Bag 3
75/7
35/4
50/4
102/12
50/12
29/3
108/9
Upland
Spiral 2
310/200
40/8
120/12
20/4
El Monte
W. Covina
60/8
Pomona
San Bernardino
Riverside
50/8
30/5
Riverside
Bag 1
46/15
Bag 2
30/6
Fullerton
40/5
Bag 4
Corona
Spiral 1
30/8
35/5
35/5
20/4
14/4
18/4
Anaheim
Los Angeles
Orange
Riverside
Orange

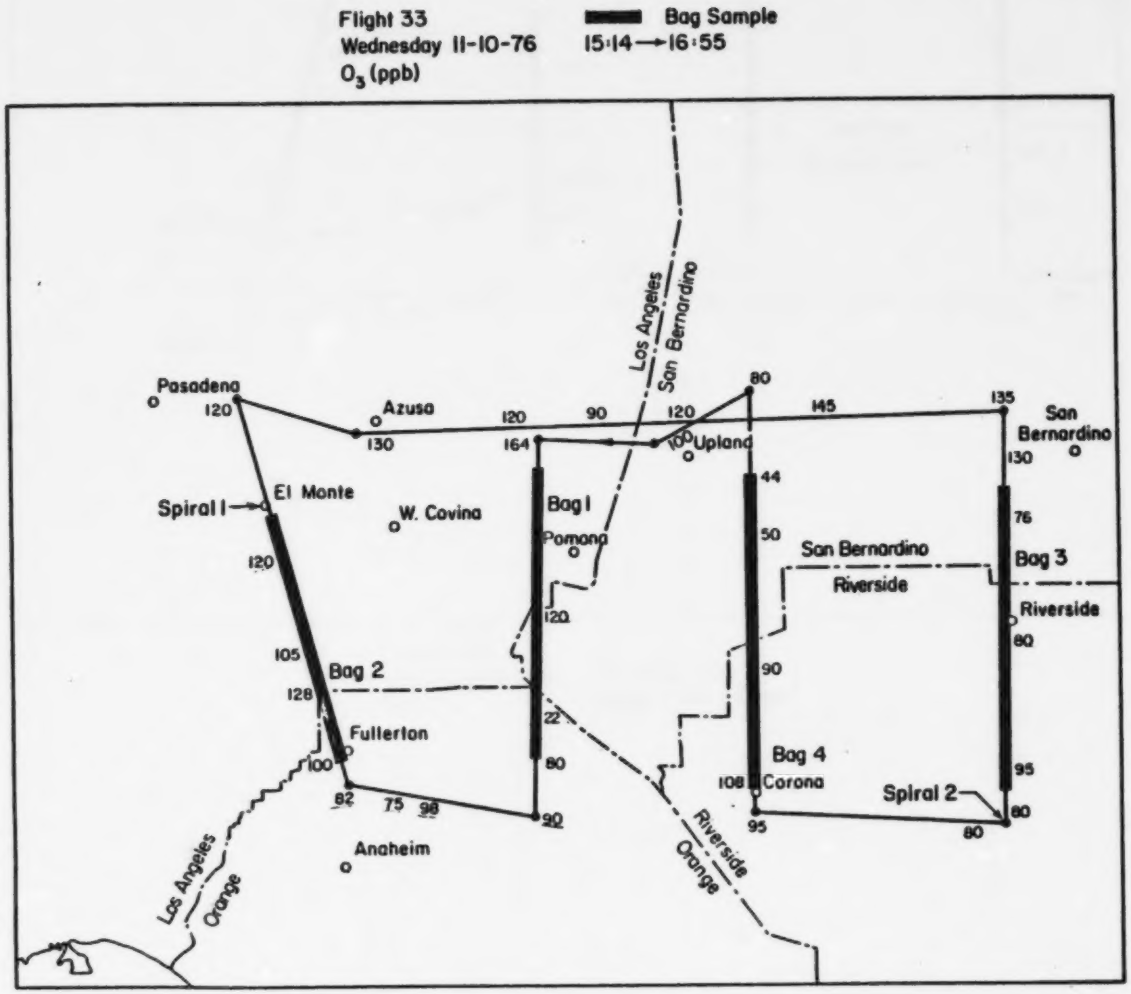
Flight 32
Wednesday 11-10-76
O_3 (ppb)


Bag Sample
11:39 → 13:21
Pasadena
130
Azusa
115
110
120
100
San Bernardino
128
126 Upland
108
96
86
Bag 1
Pomona
100
76
118
102
110
128
108
Anaheim
Fullerton
120
Bag 2
114
126
El Monte
Spiral 1
W. Covina
Los Angeles
San Bernardino
135
153
Bag 4
120
Corona
106
114
135
Spiral 2
114
110
Bag 3
114
Riverside
San Bernardino
Riverside
Riverside
Orange
Los Angeles
Orange

Flight 32
Wednesday 11-10-76
NO_x/NO (ppb)

▬ Bag Sample
11:39 → 13:21


Pasadena
130/15
Azusa
105/10
140/18
85/10
65/10
75/10
80/12
San Bernardino
Los Angeles
San Bernardino
105/15
Spiral 1
El Monte
W. Covina
110/20
170/22
85/15
Upland
Bag 1
Pomona
78/10
Bag 3
170/18
160/25
San Bernardino
Riverside
Riverside
60/10
170/18
Bag 2
70/7
Bag 4
Fullerton
70/7
Corona
Spiral 2
105/10
110/12
160/15
125/15
100/12
60/5
Anaheim
Riverside
Orange
Los Angeles
Orange

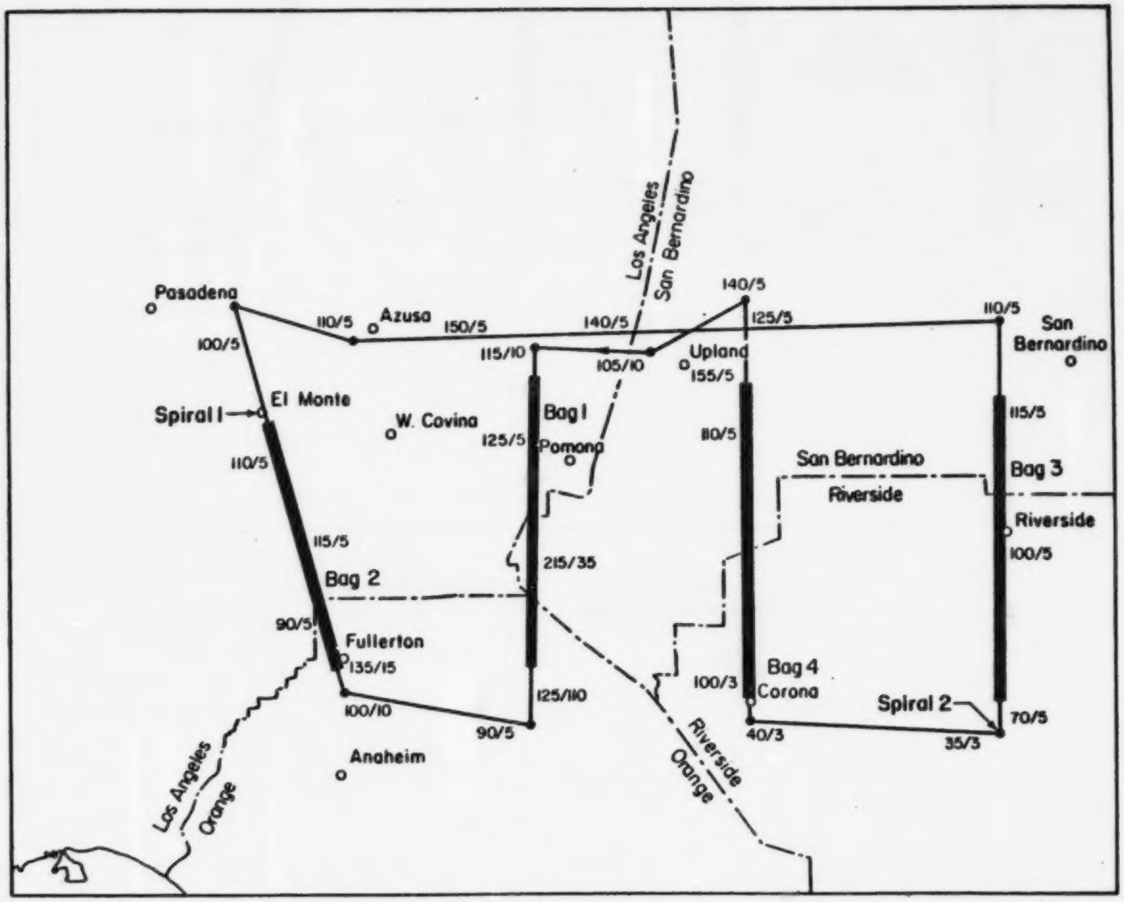


Flight 33
Wednesday 11-10-76
O_3 (ppb)

Bag Sample
15:14→16:55
Pasadena
120
Azusa
130
120
90
120
145
135
San Bernardino
130
164
100
Upland
80
Los Angeles
San Bernardino
Spiral 1
El Monte
W. Covina
Bag 1
Pomona
44
50
76
120
105
Bag 2
128
Fullerton
100
120
22
80
90
Bag 4
108
Corona
95
San Bernardino
Riverside
Bag 3
Riverside
80
95
Spiral 2
80
80
82
75
98
90
Anaheim
Los Angeles
Orange
Riverside
Orange

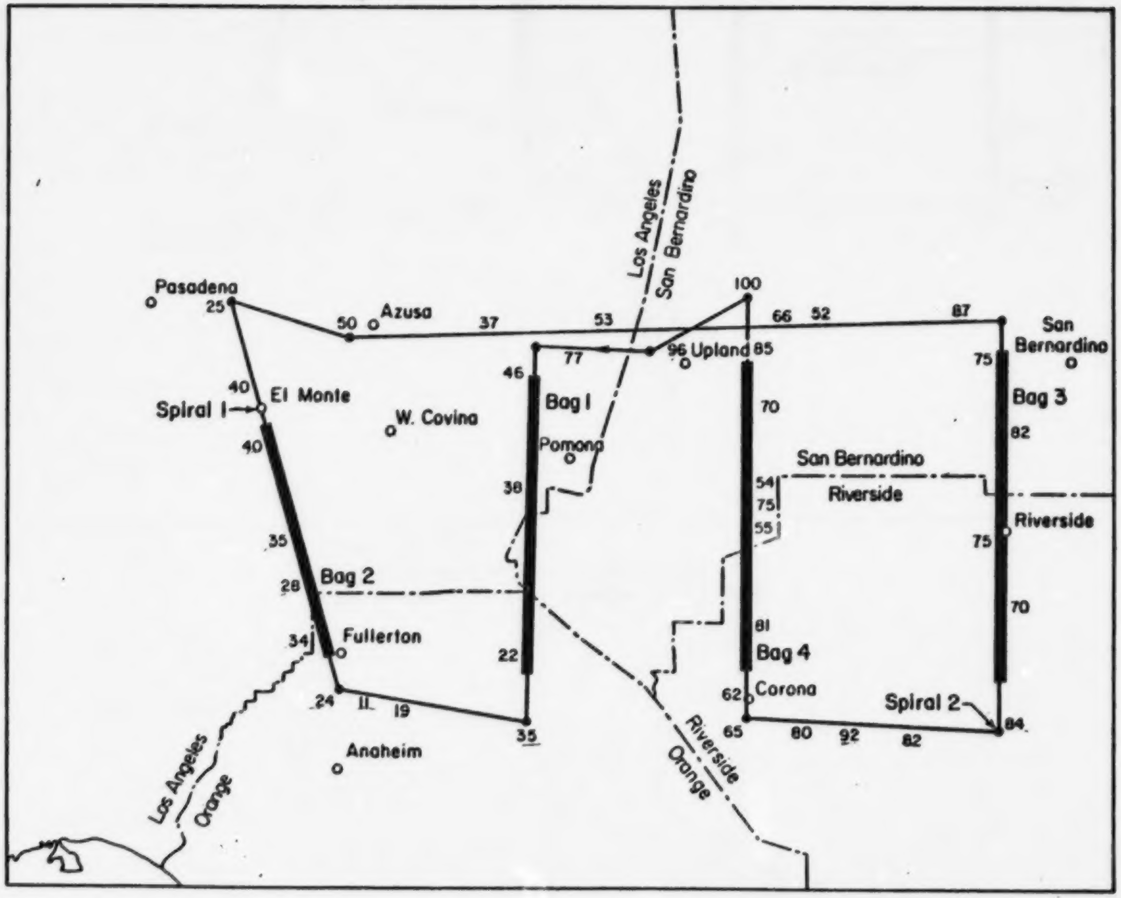
Flight 33
Wednesday 11-10-76
NO_x/NO (ppb)

▬ Bag Sample
15:14 → 16:55


Pasadena
100/5
110/5
Azusa
150/5
140/5
140/5
125/5
110/5
San Bernardino
115/10
105/10
Upland
155/5
Spiral 1
El Monte
W. Covina
Bag 1
125/5
Pomona
110/5
115/5
Bag 3
Los Angeles
San Bernardino
San Bernardino
Riverside
Riverside
100/5
110/5
115/5
215/35
Bag 2
90/5
Fullerton
135/15
100/10
90/5
125/110
100/3
Bag 4
Corona
40/3
Spiral 2
35/3
70/5
Anaheim
Riverside
Orange
Los Angeles
Orange

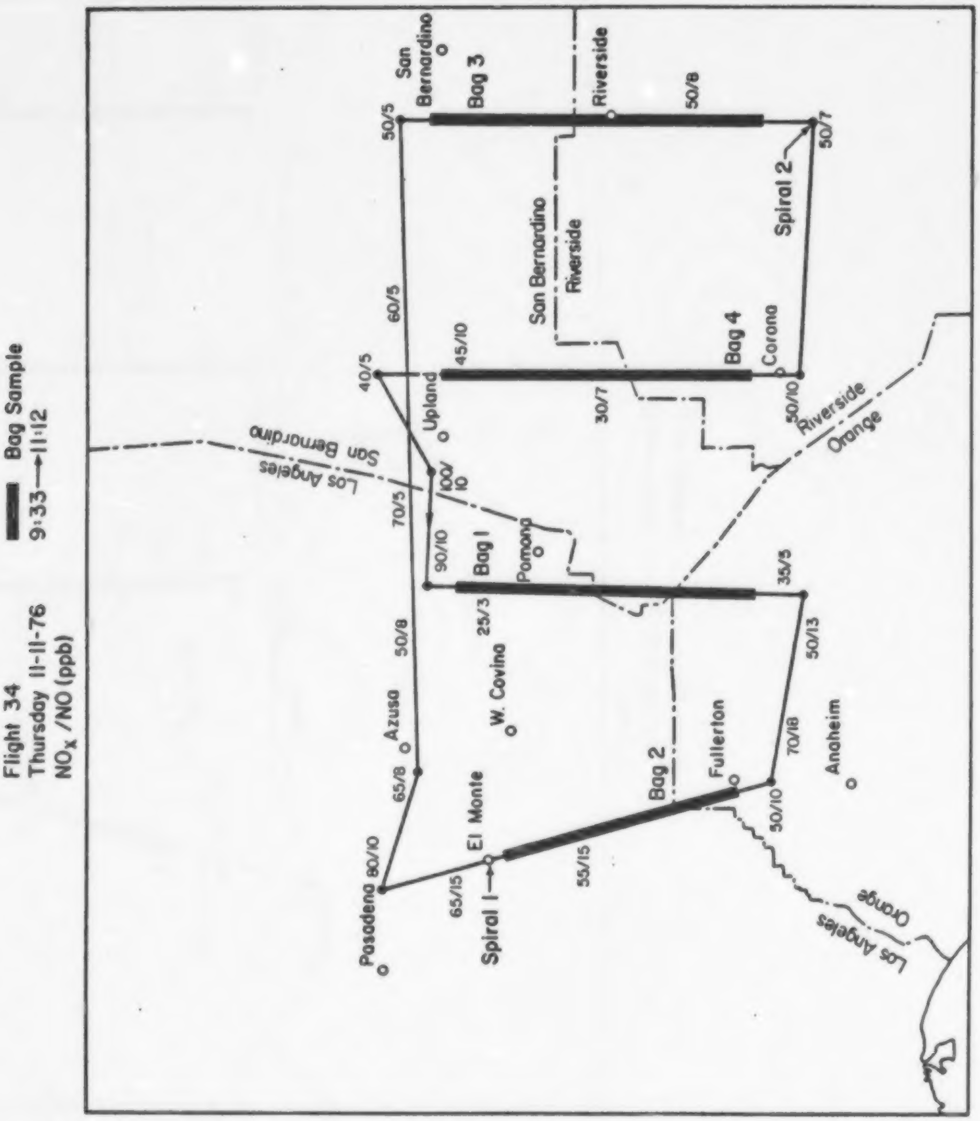
Flight 34
Thursday 11-11-76
O_3 (ppb)

▬ Bag Sample
9:33 → 11:12



Pasadena
25
50
Azusa
37
53
Los Angeles
San Bernardino
100
66
52
87
San Bernardino
40
El Monte
Spiral 1
40
W. Covina
46
77
96
Upland
85
75
Bag 3
Bag 1
70
82
Pomona
38
54
75
55
San Bernardino
Riverside
Riverside
75
35
Bag 2
28
70
34
Fullerton
22
81
Bag 4
62
Corona
Spiral 2
84
24
11
19
35
65
80
92
82
Anaheim
Riverside
Orange
Los Angeles
Orange

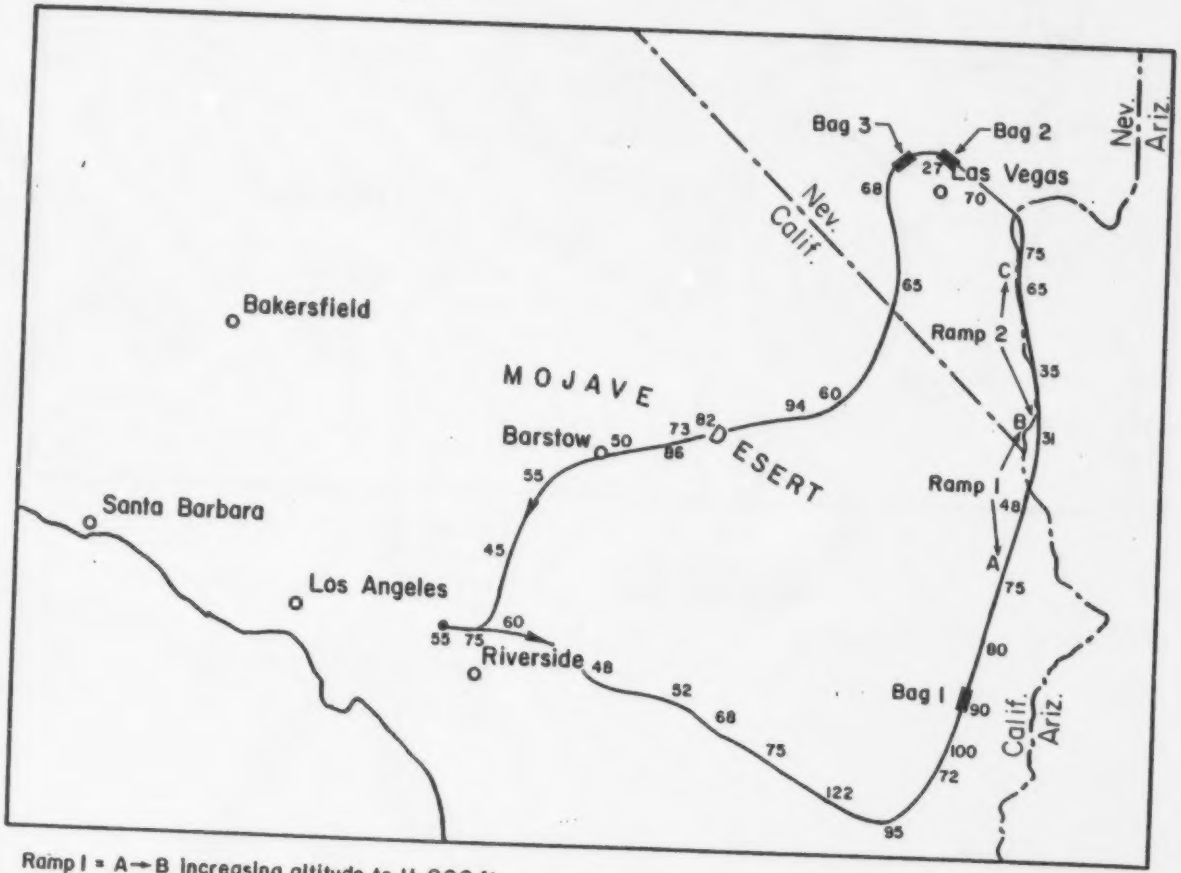
Flight 34
Thursday 11-11-76
NO_x/NO (ppb)



▬ Bag Sample
9:33 ⟶ 11:12
Pasadena
80/10
65/8
Azusa
50/8
70/5
100/10
90/10
Upland
40/5
60/5
50/5
San Bernardino
Bag 3
Riverside
50/8
50/7
Spiral 2
Corona
Bag 4
45/10
30/7
50/10
San Bernardino
Riverside
Los Angeles
San Bernardino
Riverside
Orange
Bag 1
25/3
Pomona
W. Covina
35/5
50/13
70/18
Anaheim
Fullerton
50/10
Bag 2
55/15
El Monte
65/15
Spiral 1
Los Angeles
Orange

Flight 35
Thursday 11-11-76
O_3 (ppb)

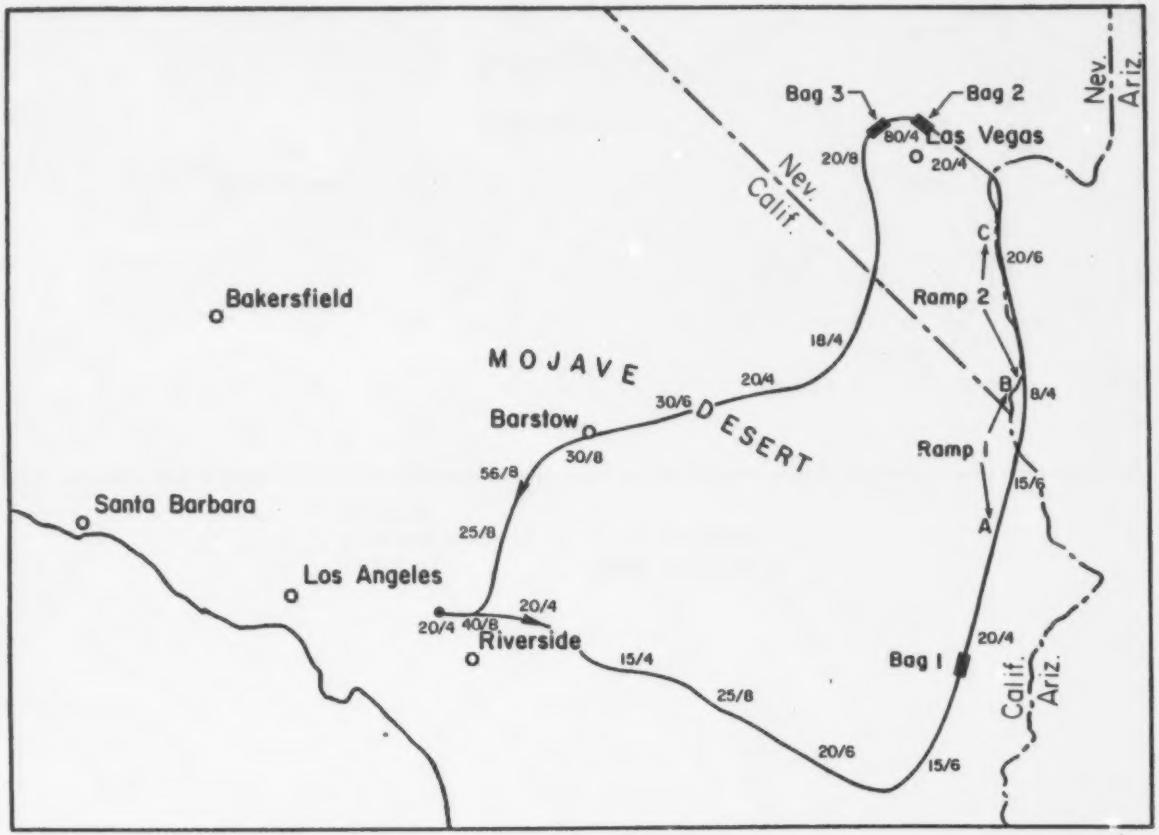
▬ Bag Sample
13:38 ⟶ 18:02


Bag 3
Bag 2
27
Las Vegas
70
Nev.
Ariz.
Nev.
Calif.
68
65
75
C
65
Ramp 2
35
Bakersfield
MOJAVE
DESERT
94
60
Barstow
50
73
82
86
B
31
Ramp 1
48
A
55
Santa Barbara
45
75
Los Angeles
60
55
75
Riverside
48
52
68
80
Bag 1
90
75
100
72
122
95
Calif.
Ariz.

Ramp 1 = A → B increasing altitude to 11,000 ft
Ramp 2 = B → C decreasing altitude from 11,000 to 3500 ft

Flight 35
Thursday 11-11-76
NO_x/NO (ppb)

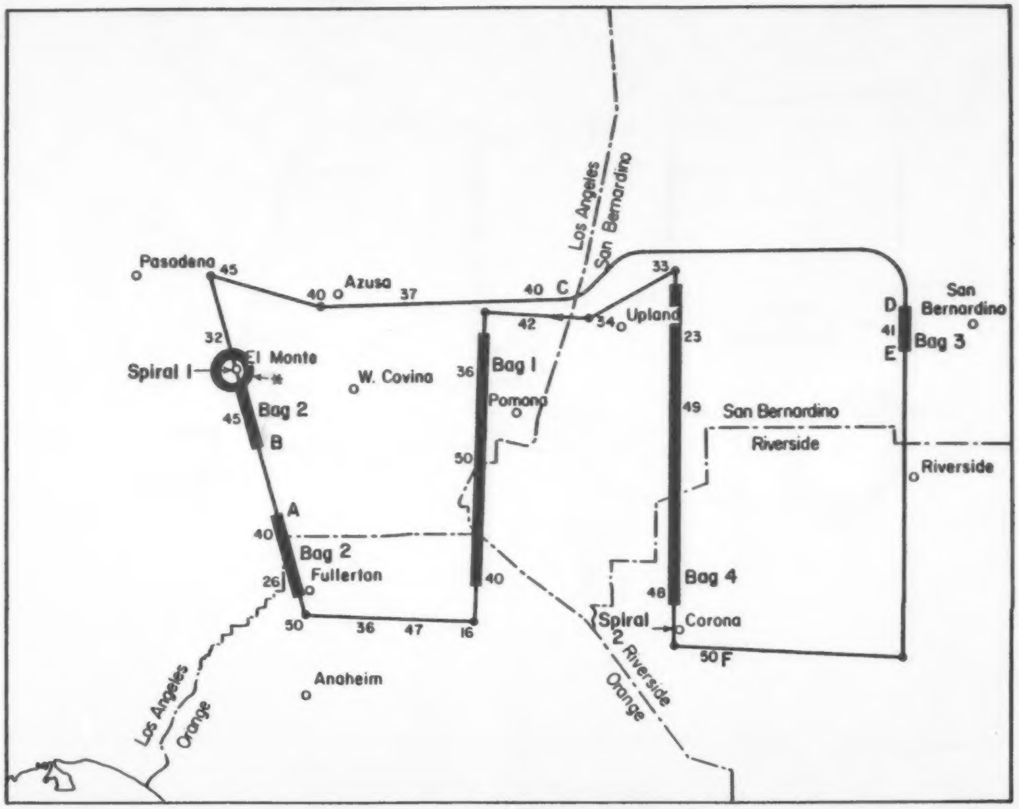
▬ Bag Sample
13:38 ⟶ 18:02


Bag 3
Bag 2
Las Vegas
Nev.
Ariz.
Nev.
Calif.
80/4
20/8
20/4
C
20/6
Ramp 2
B
8/4
Ramp 1
15/6
A
Bakersfield
MOJAVE DESERT
18/4
20/4
30/6
Barstow
30/8
56/8
Santa Barbara
25/8
Los Angeles
20/4
40/8
20/4
Riverside
15/4
25/8
20/6
15/6
20/4
Bag 1
Calif.
Ariz.

Ramp 1 = A → B increasing altitude to 11,000 ft
Ramp 2 = B → C decreasing altitude from 11,000 to 3500 ft

Flight 36
Friday 11-12-76
O_3 (ppb)

▬ Bag Sample
13:45 → 15:37

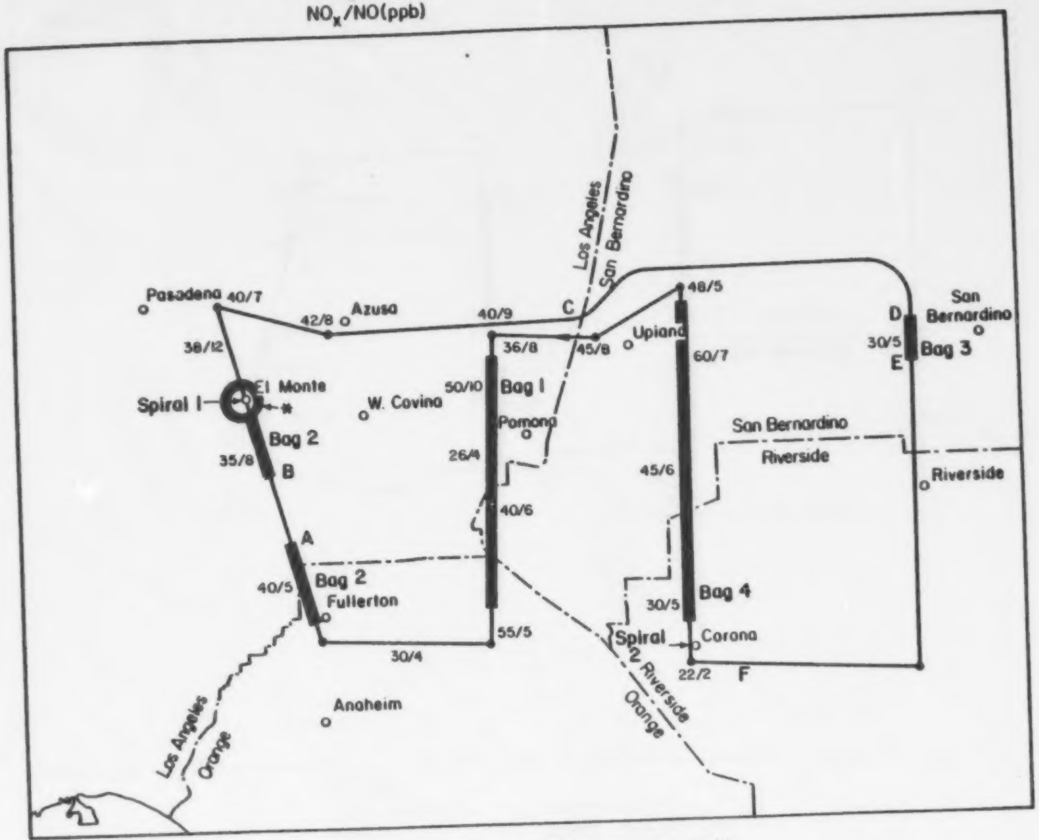

Pasadena
45
32
Spiral 1
El Monte
*
Bag 2
45
B
A
40
Bag 2
26
Fullerton
50
36
47
16
Anaheim
Los Angeles
Orange
Azusa
40
37
W. Covina
36
Bag 1
Pomona
50
40
42
40
C
Los Angeles
San Bernardino
34
Upland
33
23
49
Bag 4
48
Spiral 2
Corona
50
F
Riverside
Orange
San Bernardino
Riverside
D
41
E
Bag 3
San Bernardino
Riverside

A → B
C → D
E → F
} Rain-stopped sampling

* Circling at 1000 ft above ground to complete filling Bag 2

Flight 36
Friday 11-12-76
NO_x/NO(ppb)

▬ Bag Sample
13:45→15:37

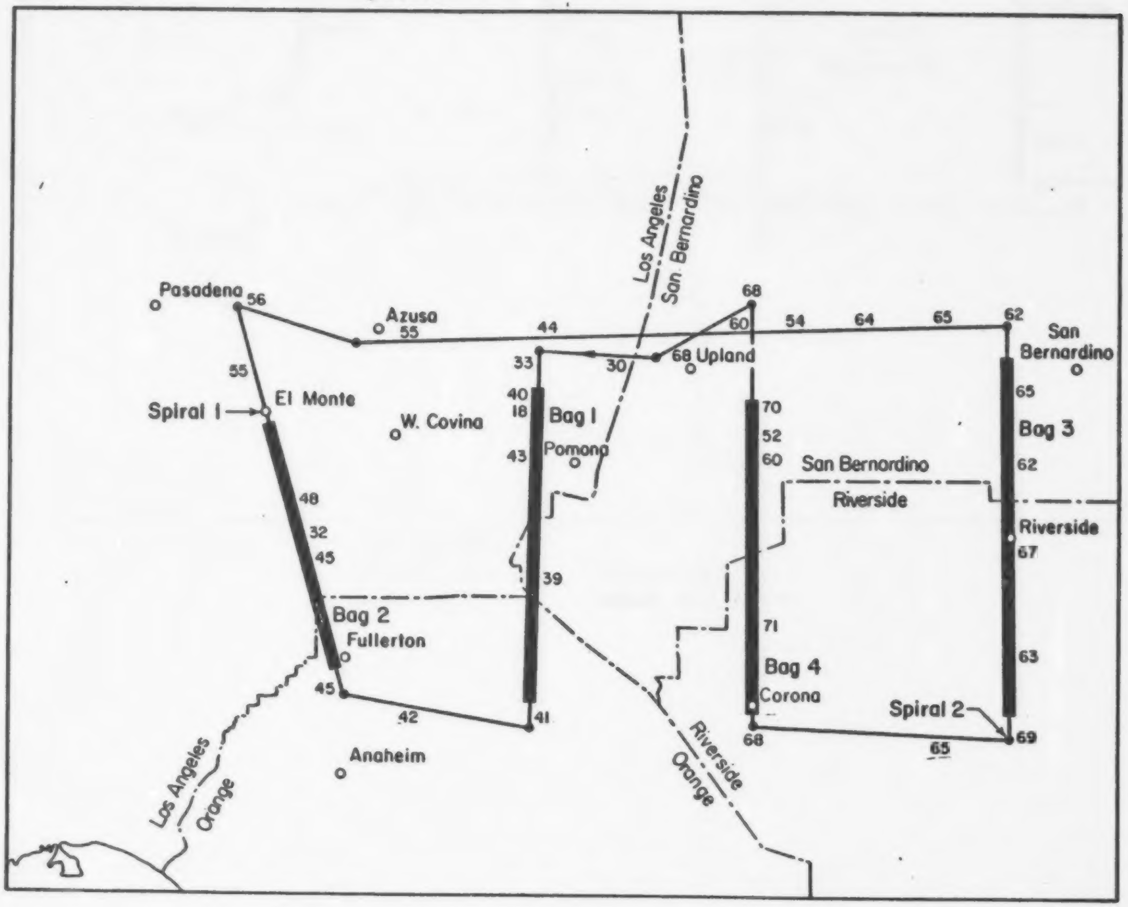


Pasadena
40/7
38/12
Spiral 1
El Monte
*
Bag 2
35/8
B
A
40/5
Bag 2
Fullerton
42/8
Azusa
W. Covina
40/9
C
Los Angeles
San Bernardino
36/8
45/8
50/10
Bag 1
Pomona
26/4
40/6
55/5
30/4
Anaheim
Los Angeles
Orange
48/5
Upland
60/7
45/6
30/5
Bag 4
Spiral 2
Corona
22/2
F
Riverside
Orange
San Bernardino
Riverside
D
30/5
E
Bag 3
San Bernardino
Riverside

A→B
C→D
E→F } Rain-stopped sampling

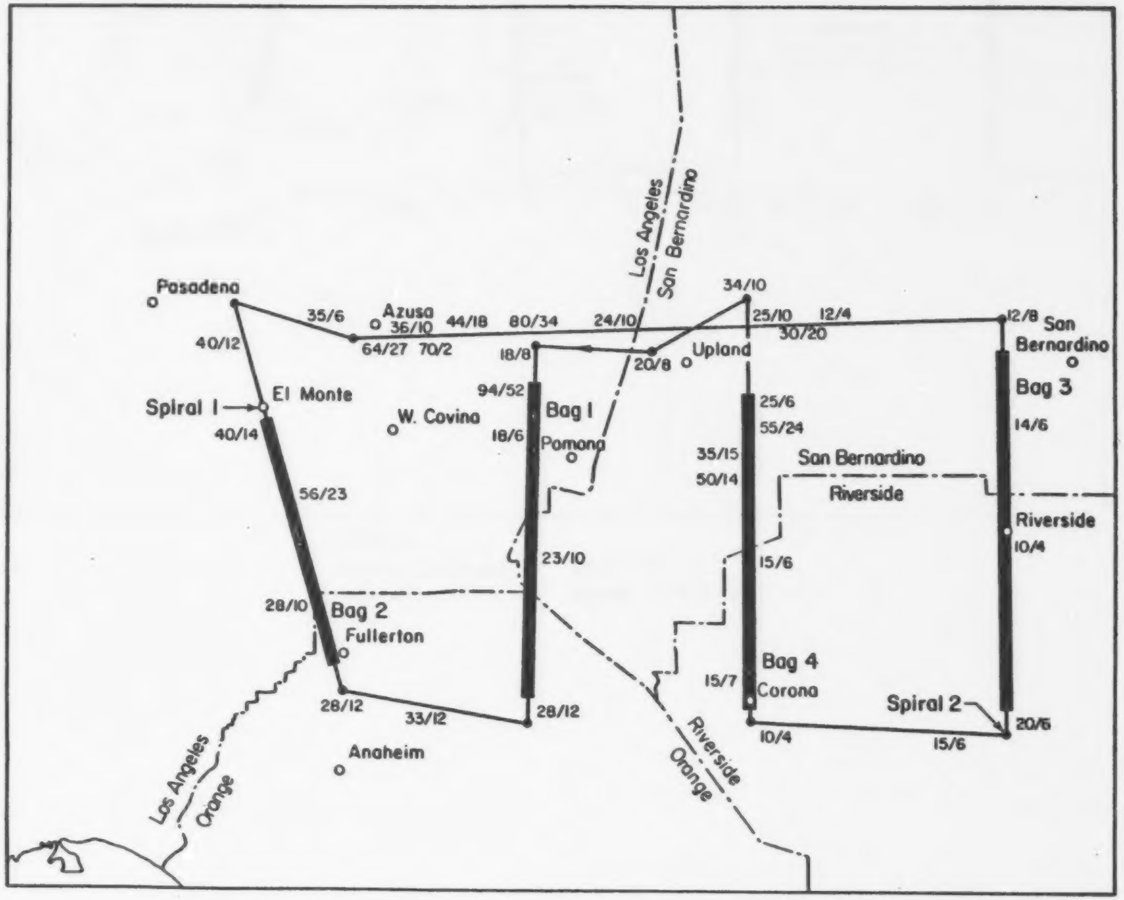
* Circling at 1000 ft above ground to complete filling Bag 2

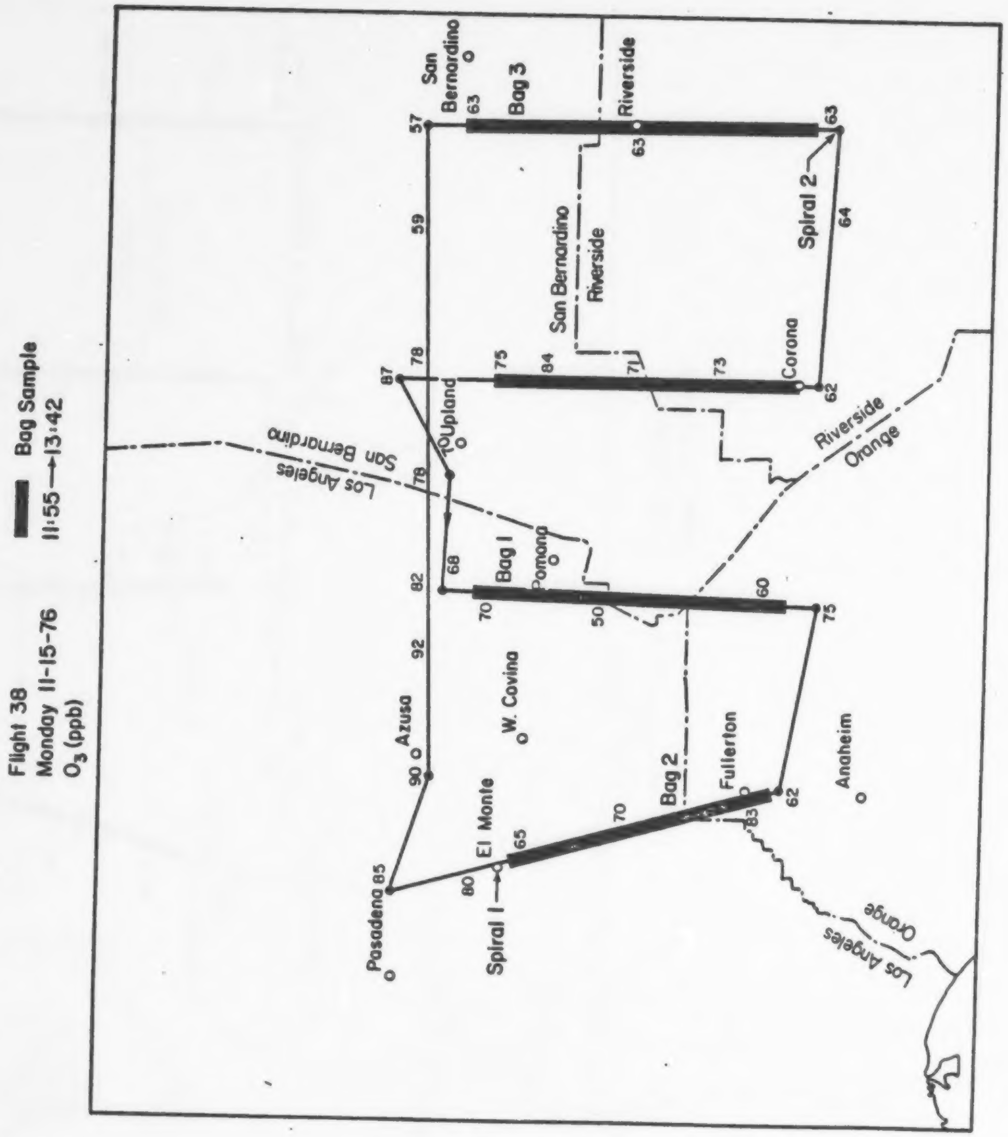
Flight 37
Monday 11-15-76
O_3(ppb)


Bag Sample
8:58 → 10:47
Pasadena
56
Azusa
55
44
El Monte
Spiral 1
55
W. Covina
48
32
45
Bag 2
Fullerton
45
42
Anaheim
Los Angeles
Orange
33
40
18
43
Bag 1
Pomona
39
41
30
68 Upland
Los Angeles
San Bernardino
68
60
54
64
65
62
70
52
60
71
Bag 4
Corona
68
San Bernardino
Riverside
Riverside
Orange
San Bernardino
65
Bag 3
62
Riverside
67
63
Spiral 2
69
65

Flight 37
Monday 11-15-76
NO_x/NO(ppb)

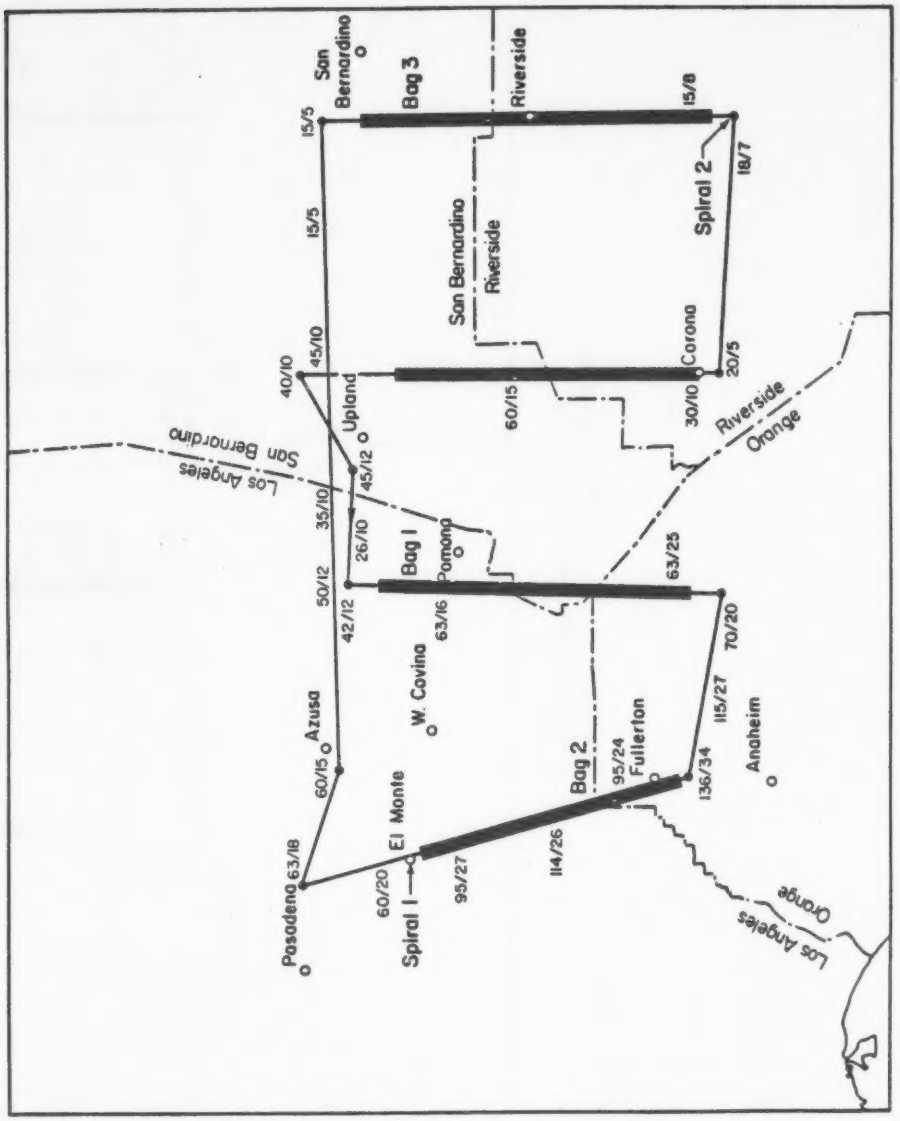
▬ Bag Sample
8:58 → 10:47


Pasadena
40/12
35/6
Azusa
36/10
64/27
70/2
44/18
80/34
24/10
Los Angeles
San Bernardino
34/10
25/10
12/4
30/20
12/8
San Bernardino
Spiral 1
El Monte
40/14
W. Covina
56/23
28/10
Bag 2
Fullerton
28/12
33/12
Anaheim
Los Angeles
Orange
18/8
94/52
Bag 1
18/6
Pomona
23/10
28/12
20/8
Upland
25/6
55/24
35/15
50/14
15/6
Bag 4
15/7
Corona
10/4
Riverside
Orange
San Bernardino
Riverside
Bag 3
14/6
Riverside
10/4
Spiral 2
20/6
15/6


Flight 38
Monday 11-15-76
O_3 (ppb)
Bag Sample
11:55 → 13:42
Pasadena
Azusa
El Monte
W. Covina
Pomona
Upland
San Bernardino
Riverside
Corona
Fullerton
Anaheim
Spiral 1
Spiral 2
Bag 1
Bag 2
Bag 3
Los Angeles
San Bernardino
Riverside
Orange
San Bernardino
Riverside
Los Angeles
Orange
85
80
65
70
83
62
90
92
82
70
68
50
60
75
78
70
87
78
75
84
71
73
62
59
57
63
63
64
63

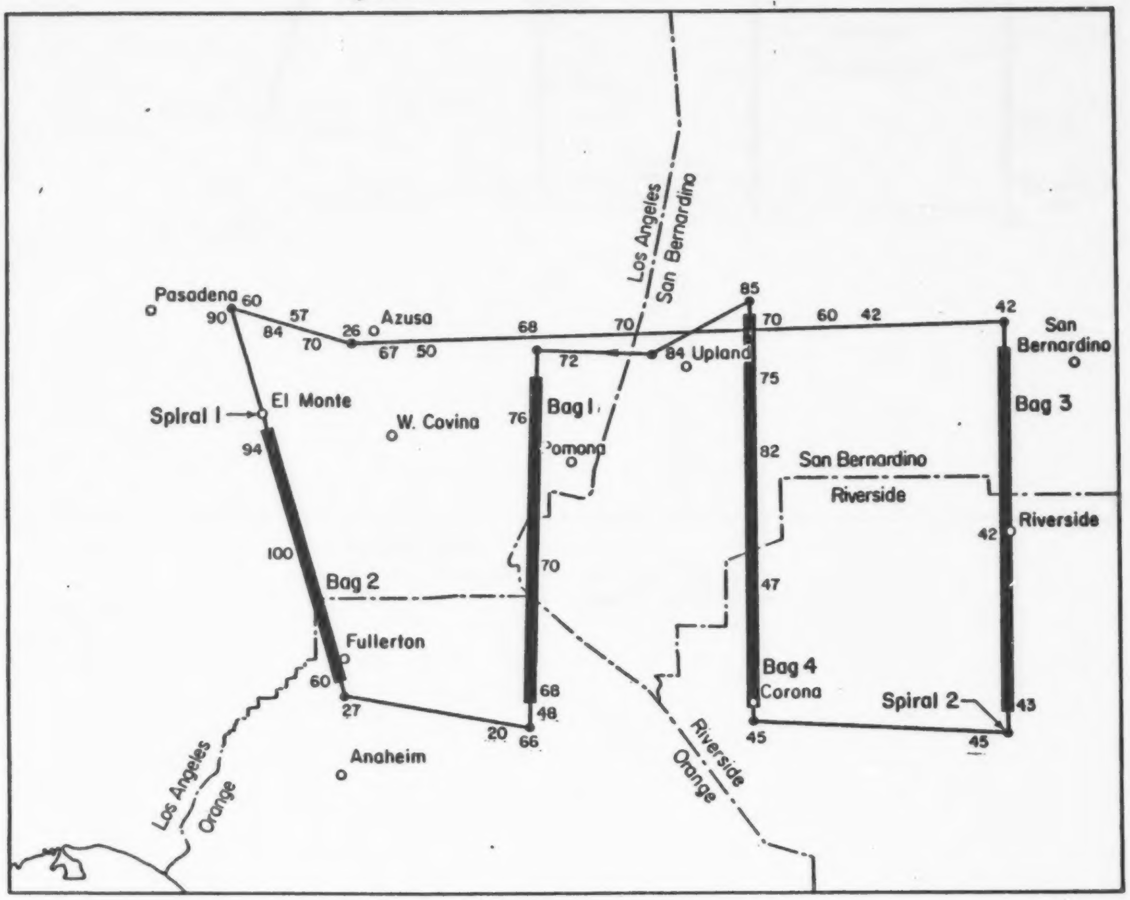
Flight 38
Monday 11-15-76
NO_x/NO(ppb)

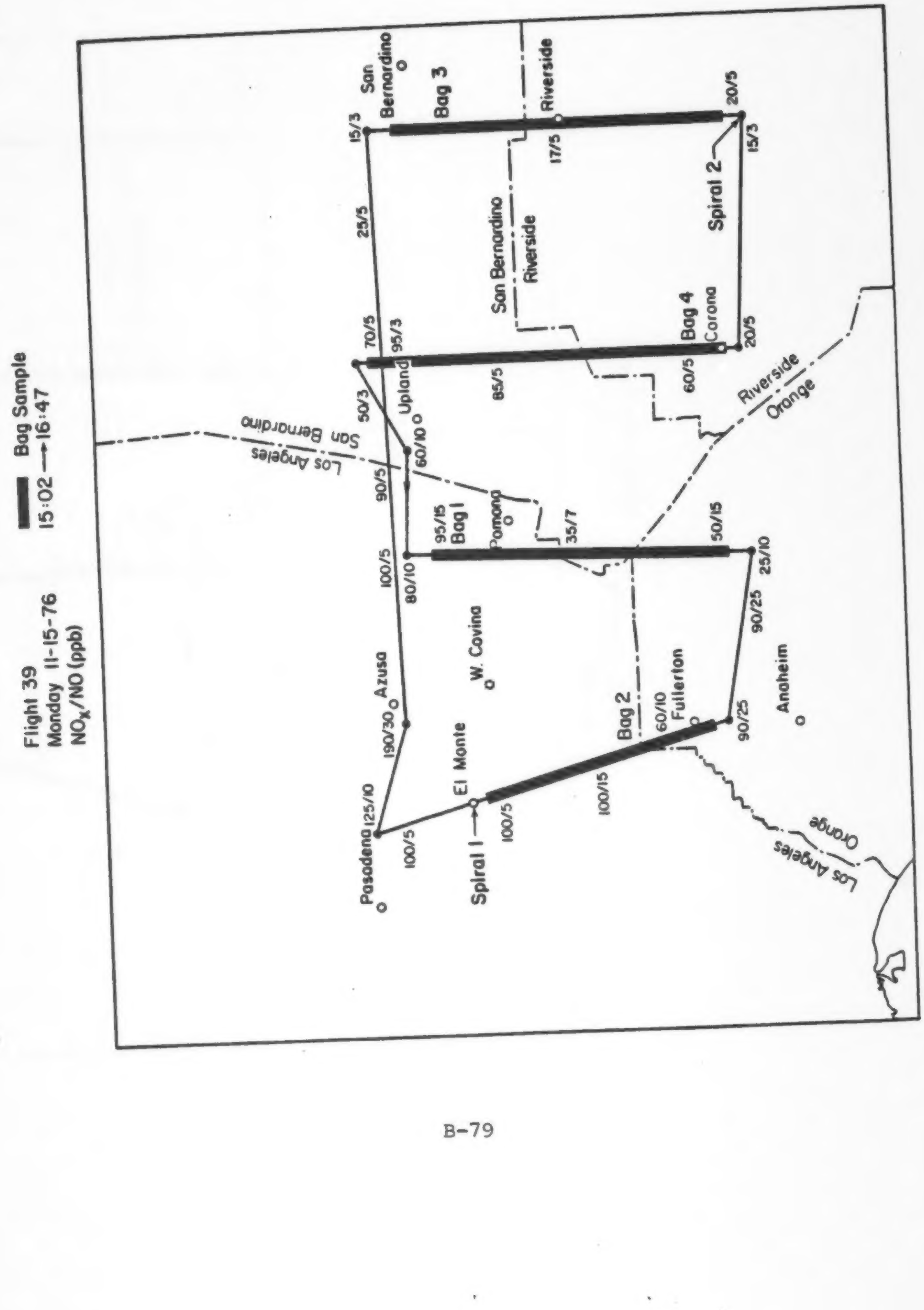
▬ Bag Sample
11:55 → 13:42


Pasadena
63/18
60/15
Azusa
50/12
42/12
35/10
26/10
45/12
Upland
40/10
45/10
15/5
15/5
San Bernardino
Spiral 1
60/20
El Monte
95/27
114/26
Bag 2
95/24
Fullerton
136/34
Anaheim
W. Covina
63/16
115/27
70/20
Bag 1
Pomona
63/25
60/15
30/10
Corona
20/5
Bag 3
San Bernardino
Riverside
Riverside
15/8
Spiral 2
18/7
Los Angeles
San Bernardino
Riverside
Orange
Los Angeles
Orange

Flight 39
Monday 11-15-76
O_3 (ppb)

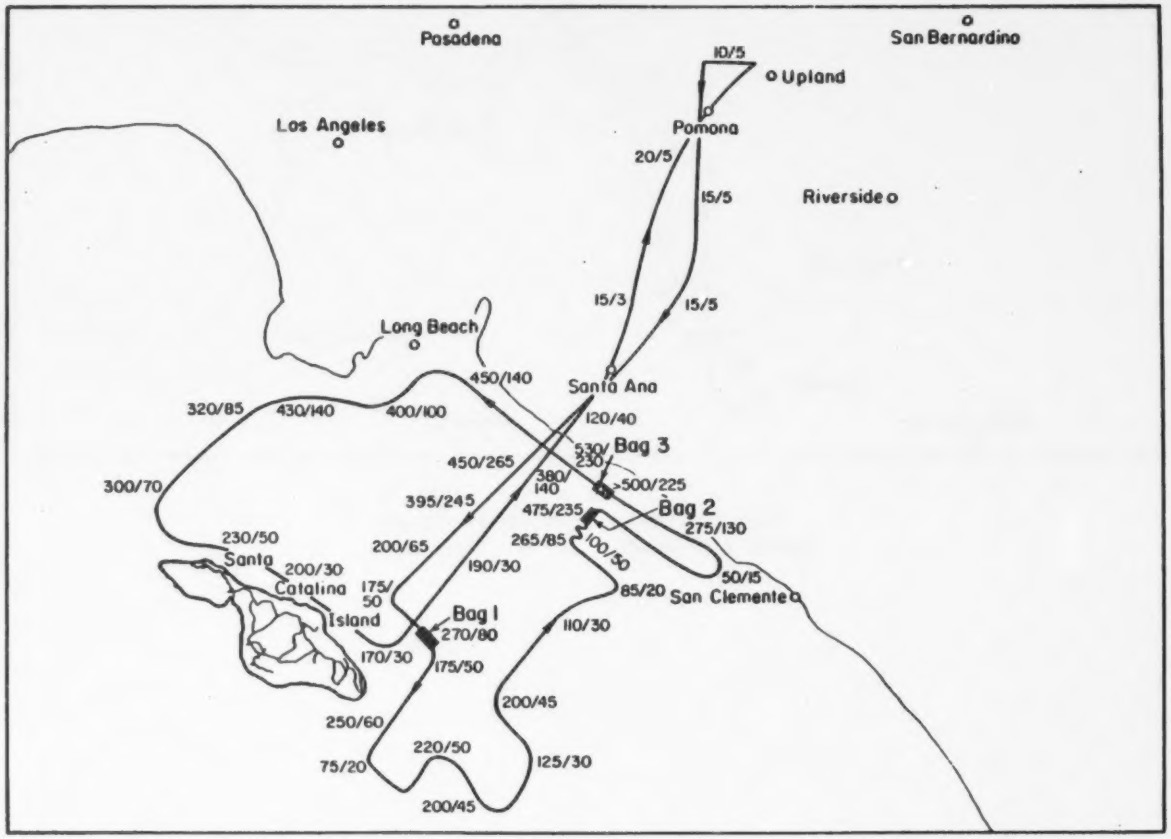
▬ Bag Sample
15:02 → 16:47


Pasadena
60
90
57
84
70
26
Azusa
67
50
68
70
72
84 Upland
85
70
60
42
42
San Bernardino
Los Angeles
San Bernardino
Spiral 1
El Monte
W. Covina
94
76
Bag 1
Pomona
75
82
Bag 3
San Bernardino
Riverside
42
Riverside
100
Bag 2
Fullerton
70
47
Bag 4
Corona
60
27
68
48
20
66
45
Spiral 2
43
45
Anaheim
Los Angeles
Orange
Riverside
Orange


Flight 39
Monday 11-15-76
NO$_x$/NO (ppb)
Bag Sample
15:02 → 16:47
Pasadena
125/10
100/5
190/30
Azusa
100/5
80/10
90/5
60/10
50/3
Upland
70/5
95/3
25/5
15/3
San Bernardino
Bag 3
Riverside
17/5
20/5
15/3
Spiral 2
Bag 4
Corona
20/5
60/5
85/5
San Bernardino
Riverside
Riverside
Orange
Los Angeles
San Bernardino
Pomona
95/15
Bag 1
35/7
50/15
25/10
90/25
W. Covina
El Monte
Spiral 1
100/5
100/15
Bag 2
60/10
Fullerton
90/25
Anaheim
Los Angeles
Orange

Flight 40
Tuesday 11-16-76
NO_x/NO (ppb)

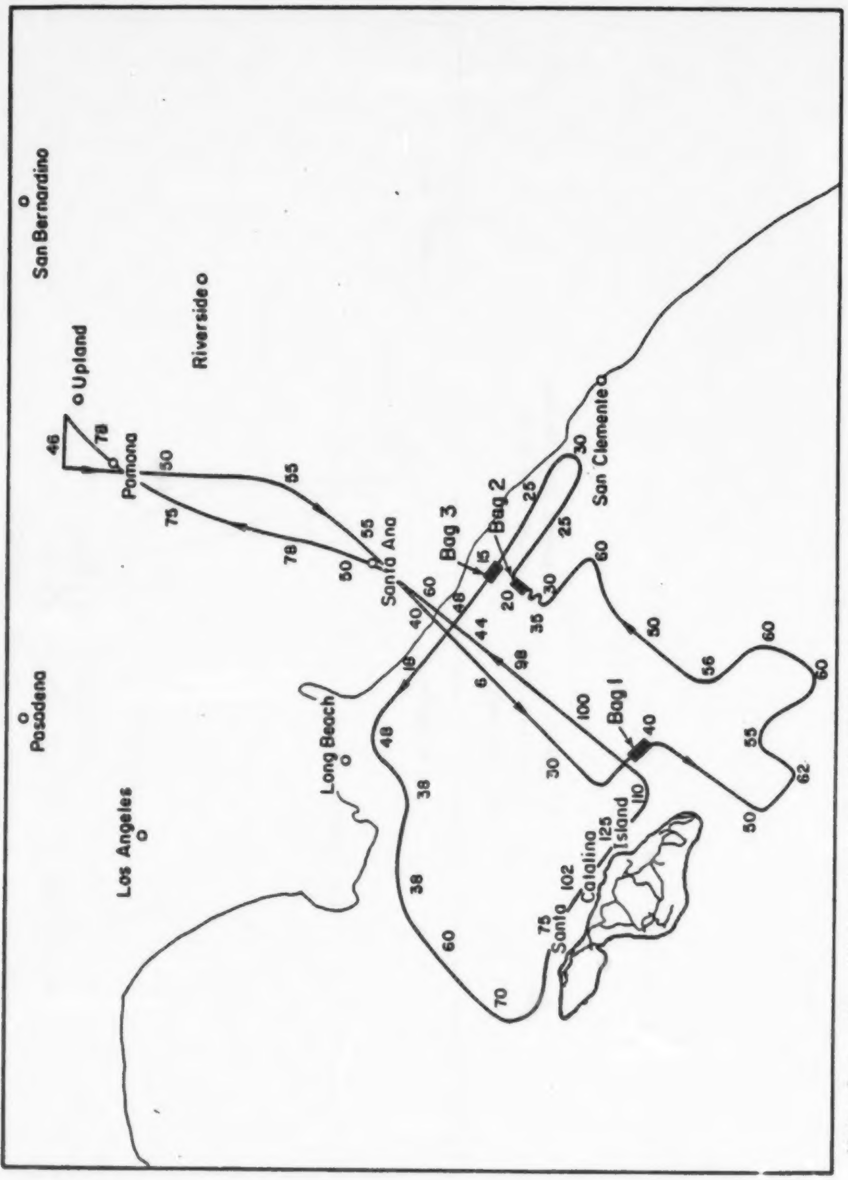
▬ Bag Sample
8:46 ⟶ 11:15


Pasadena
San Bernardino
10/5
Upland
Los Angeles
Pomona
20/5
15/5
Riverside
15/3
15/5
Long Beach
450/140
Santa Ana
320/85
430/140
400/100
120/40
530/230
Bag 3
450/265
380/140
>500/225
300/70
395/245
475/235
Bag 2
275/130
230/50
200/65
265/85
100/50
Santa
200/30
190/30
50/15
Catalina
175/50
85/20
San Clemente
Island
Bag 1
270/80
110/30
170/30
175/50
200/45
250/60
220/50
125/30
75/20
200/45

Note: Over water-altitude varied from 50 to100 ft. above surface.

Flight 40
Tuesday 11-16-76
O_3 (ppb)

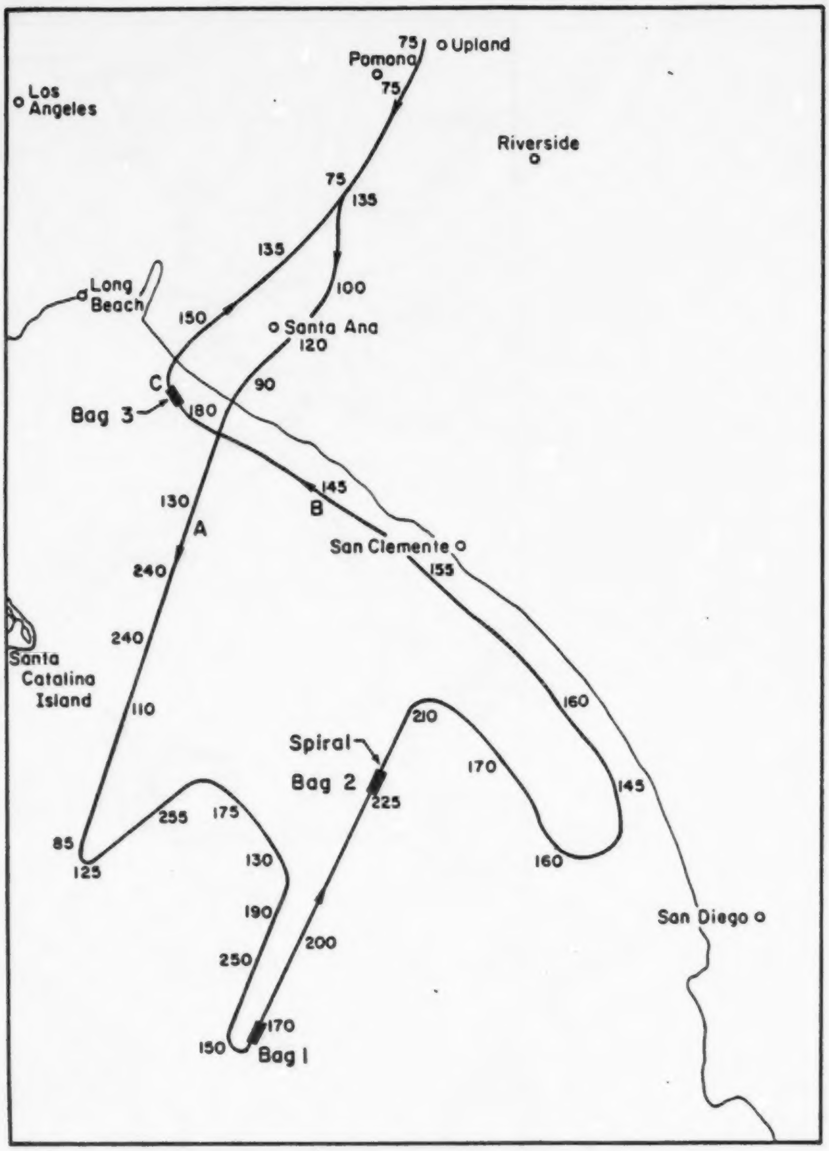
▬ Bag Sample
8:46 ⟶ 11:15


San Bernardino
Upland
Riverside
Pomona
Pasadena
Los Angeles
Long Beach
Santa Ana
San Clemente
Santa Catalina Island
Bag 1
Bag 2
Bag 3
46
78
50
55
75
78
55
50
60
40
48
15
25
30
25
20
35
30
60
44
18
98
6
50
60
56
60
48
100
40
55
38
30
110
125
102
75
38
60
70
50
62

Note: Over water-altitude varied from 50 to 100 ft. above surface.

Flight 41
Tuesday 11-16-76
O_3 (ppb)

▬ Bag Sample
13:00 → 15:38

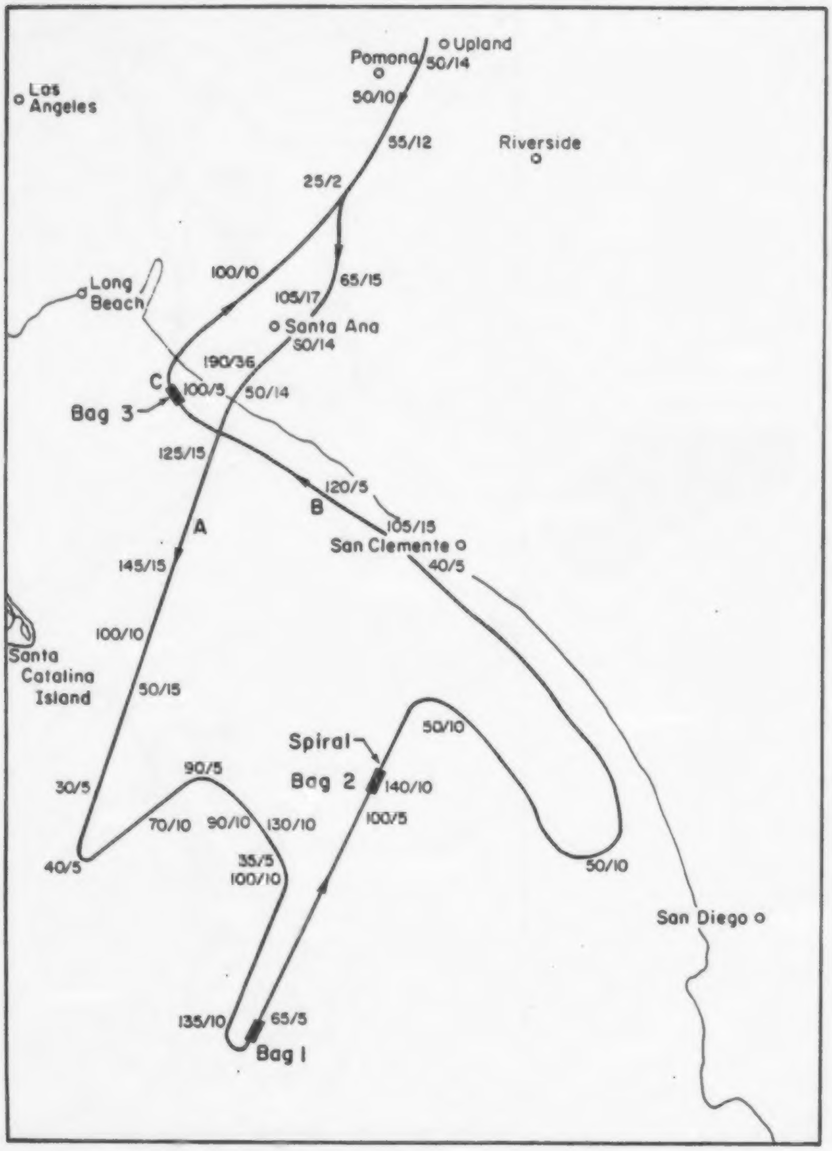


75
Upland
Pomona
75
Los Angeles
Riverside
75
135
135
100
Long Beach
150
Santa Ana
120
C
90
Bag 3
180
145
B
130
A
San Clemente
155
240
240
Santa Catalina Island
160
110
210
Spiral
170
Bag 2
145
225
255
175
85
125
160
130
190
San Diego
200
250
170
150
Bag 1

A → B 100 ft above water
B → C 200 ft above water

Flight 41
Tuesday 11-16-76
NO_x/NO (ppb)

▬ Bag Sample
13:00 ⟶ 15:38

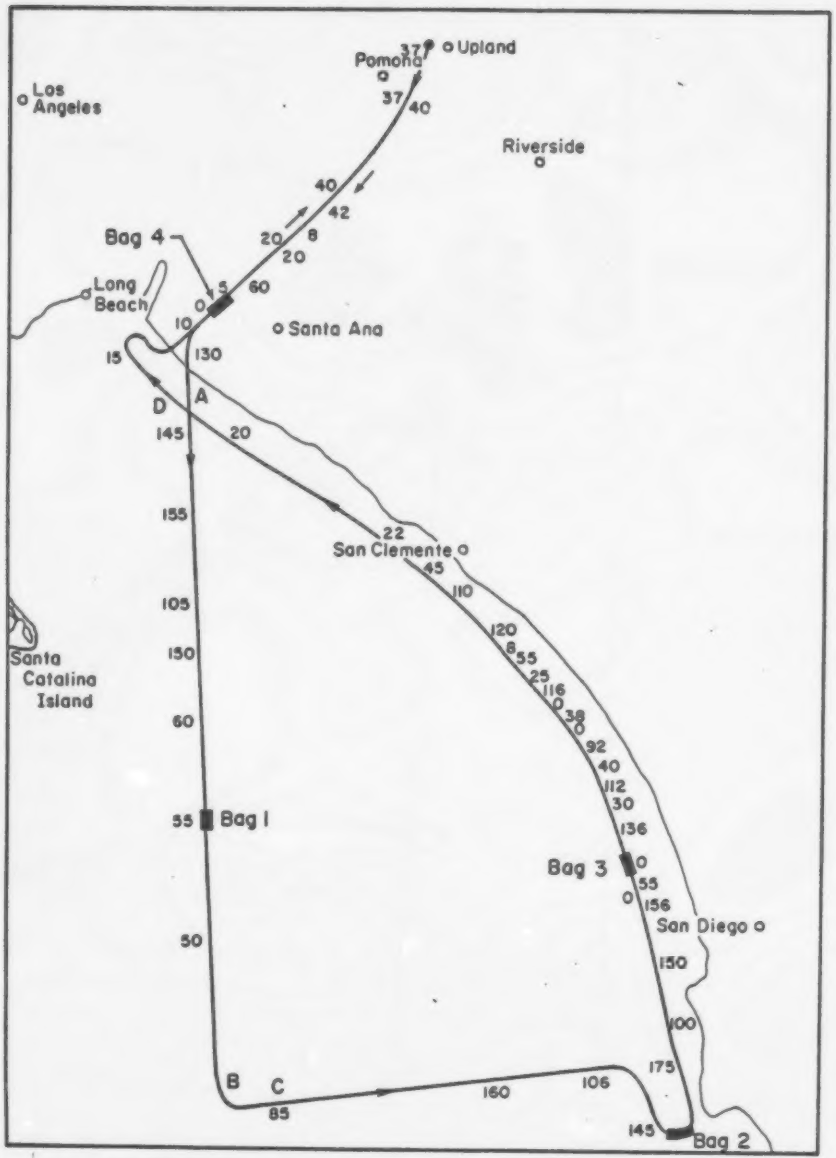


Upland
Pomona
50/14
50/10
Los Angeles
55/12
Riverside
25/2
100/10
65/15
Long Beach
105/17
Santa Ana
50/14
190/36
C
100/5
50/14
Bag 3
125/15
120/5
B
A
105/15
San Clemente
40/5
145/15
100/10
Santa Catalina Island
50/15
50/10
Spiral
Bag 2
140/10
90/5
30/5
100/5
70/10
90/10
130/10
40/5
35/5
100/10
50/10
San Diego
135/10
65/5
Bag 1

A→B 100 ft above water
B→C 200 ft above water

Flight 42
Tuesday 11-16-76
O_3 (ppb)

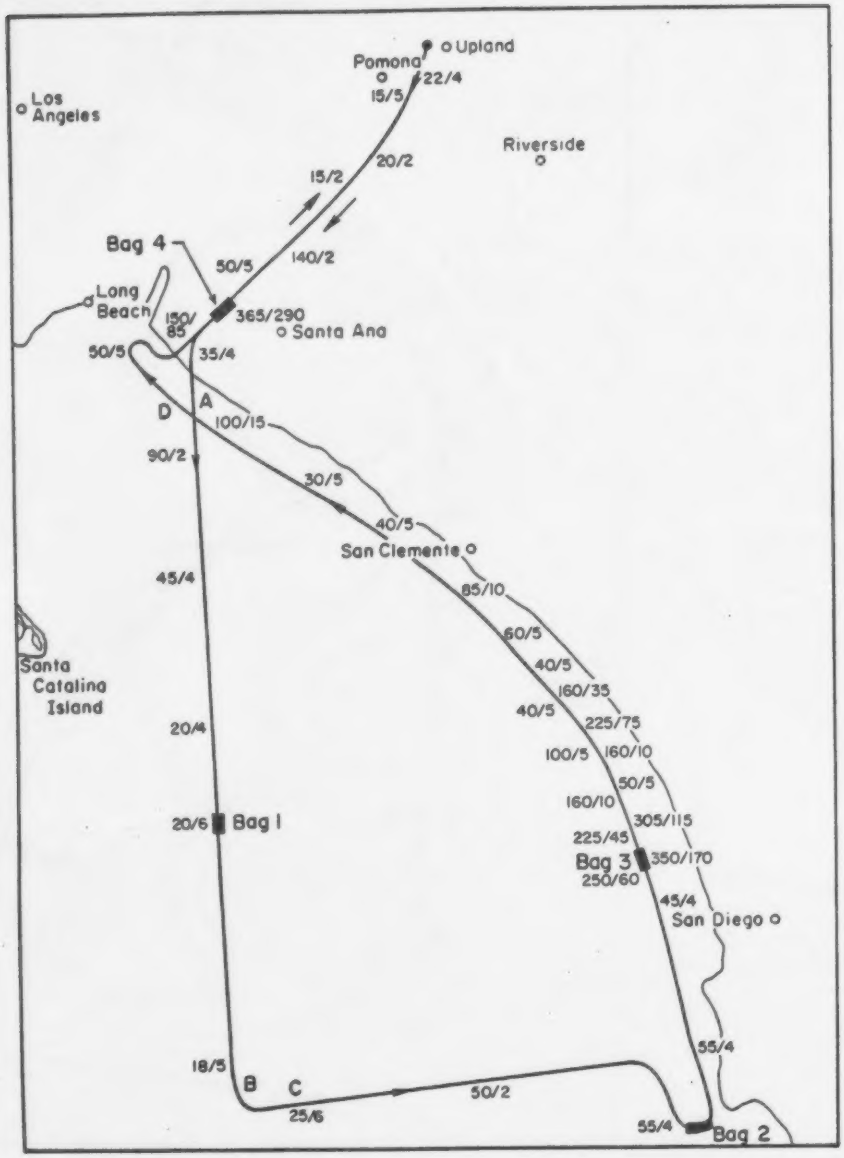
▬ Bag Sample
17:00 → 19:21


Upland
Pomona
37
37
40
Los Angeles
Riverside
40
42
20
8
20
Bag 4
5
60
0
Long Beach
10
Santa Ana
15
130
D
A
145
20
155
22
San Clemente
45
110
105
120
8
55
150
25
116
0
38
0
Santa Catalina Island
60
92
40
112
30
55
Bag 1
136
Bag 3
0
55
0
156
San Diego
50
150
100
175
B
C
85
160
106
145
Bag 2

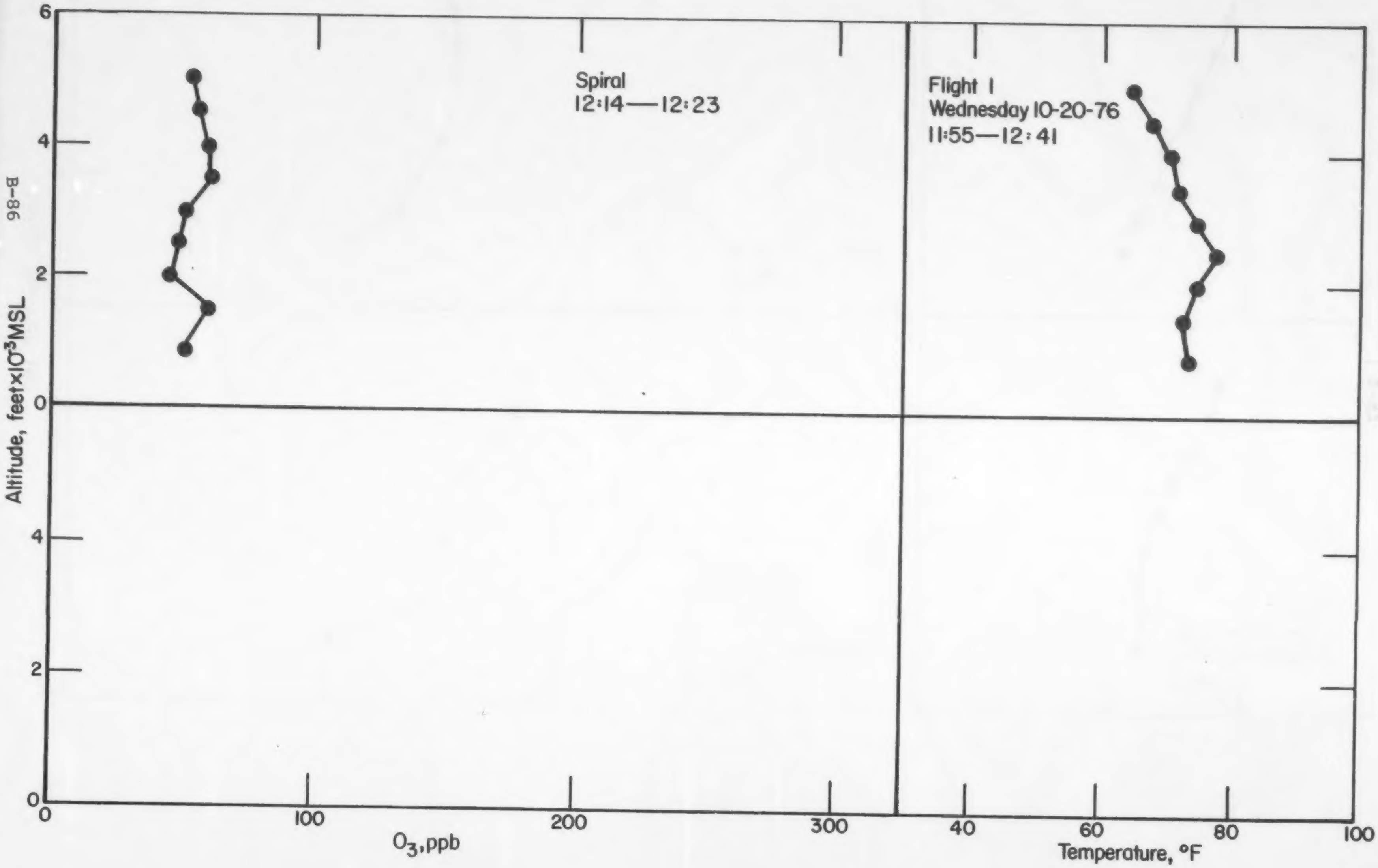
A→B 100 ft above water
C→D 200 ft above water

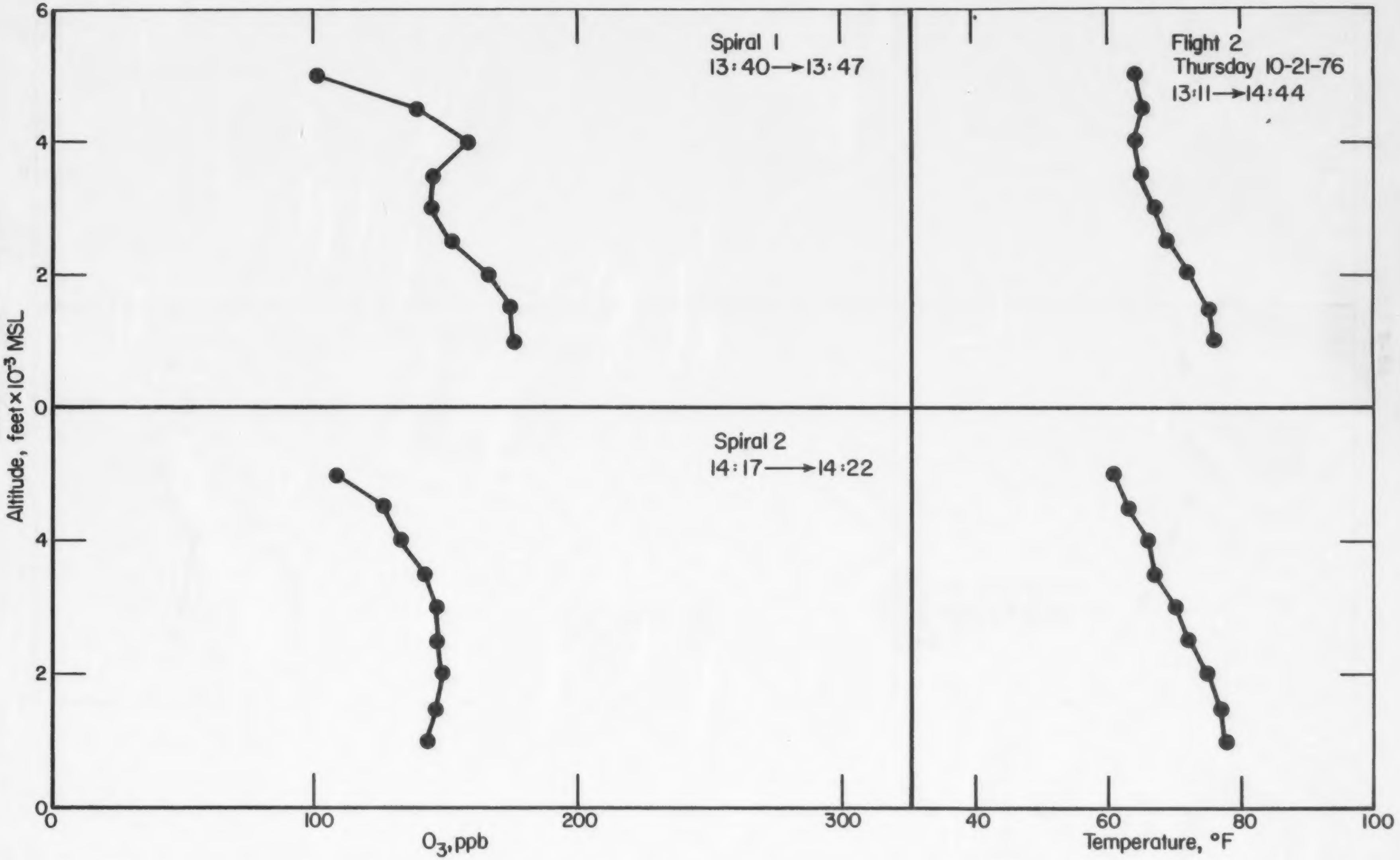
Flight 42
Tuesday 11-16-76
NO_x/NO(ppb)

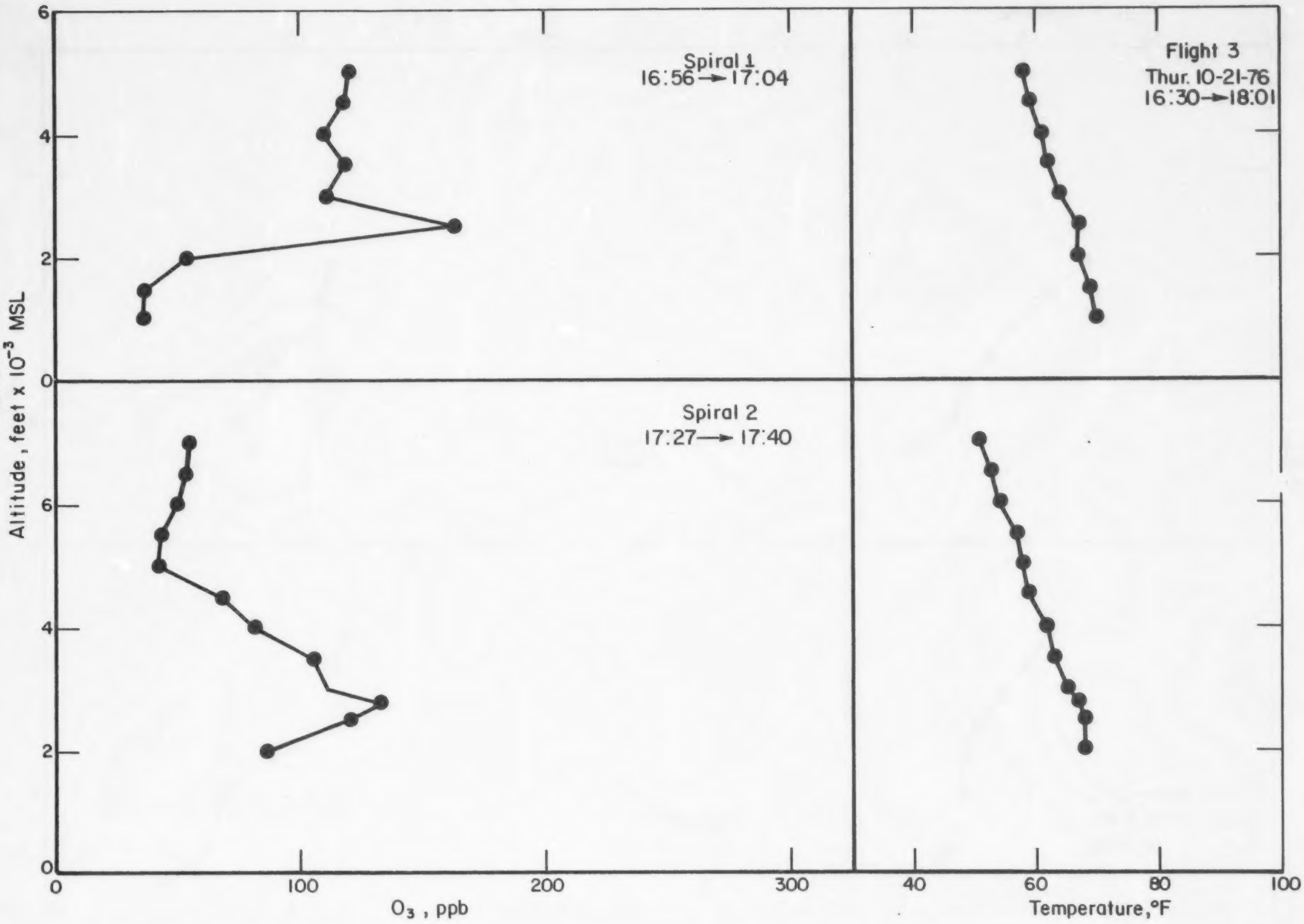
▬ Bag Sample
17:00 → 19:21

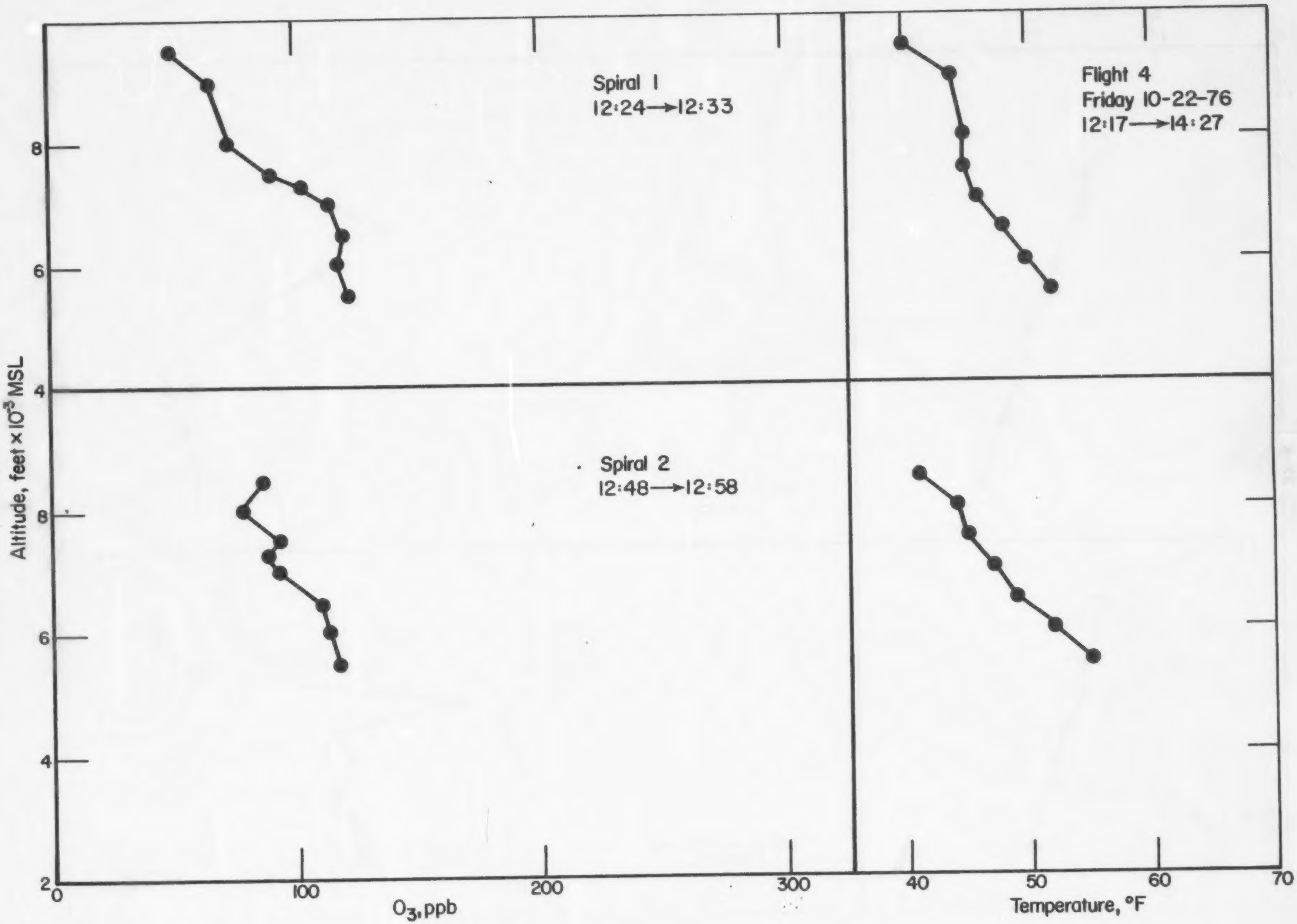

Upland
Pomona
22/4
15/5
Los Angeles
Riverside
20/2
15/2
Bag 4
50/5
140/2
Long Beach
150/85
365/290
Santa Ana
50/5
35/4
D
A
100/15
90/2
30/5
40/5
San Clemente
45/4
85/10
60/5
40/5
160/35
40/5
225/75
Santa Catalina Island
20/4
100/5
160/10
50/5
160/10
305/115
20/6
Bag 1
225/45
Bag 3
350/170
250/60
45/4
San Diego
55/4
18/5
B
C
50/2
25/6
55/4
Bag 2

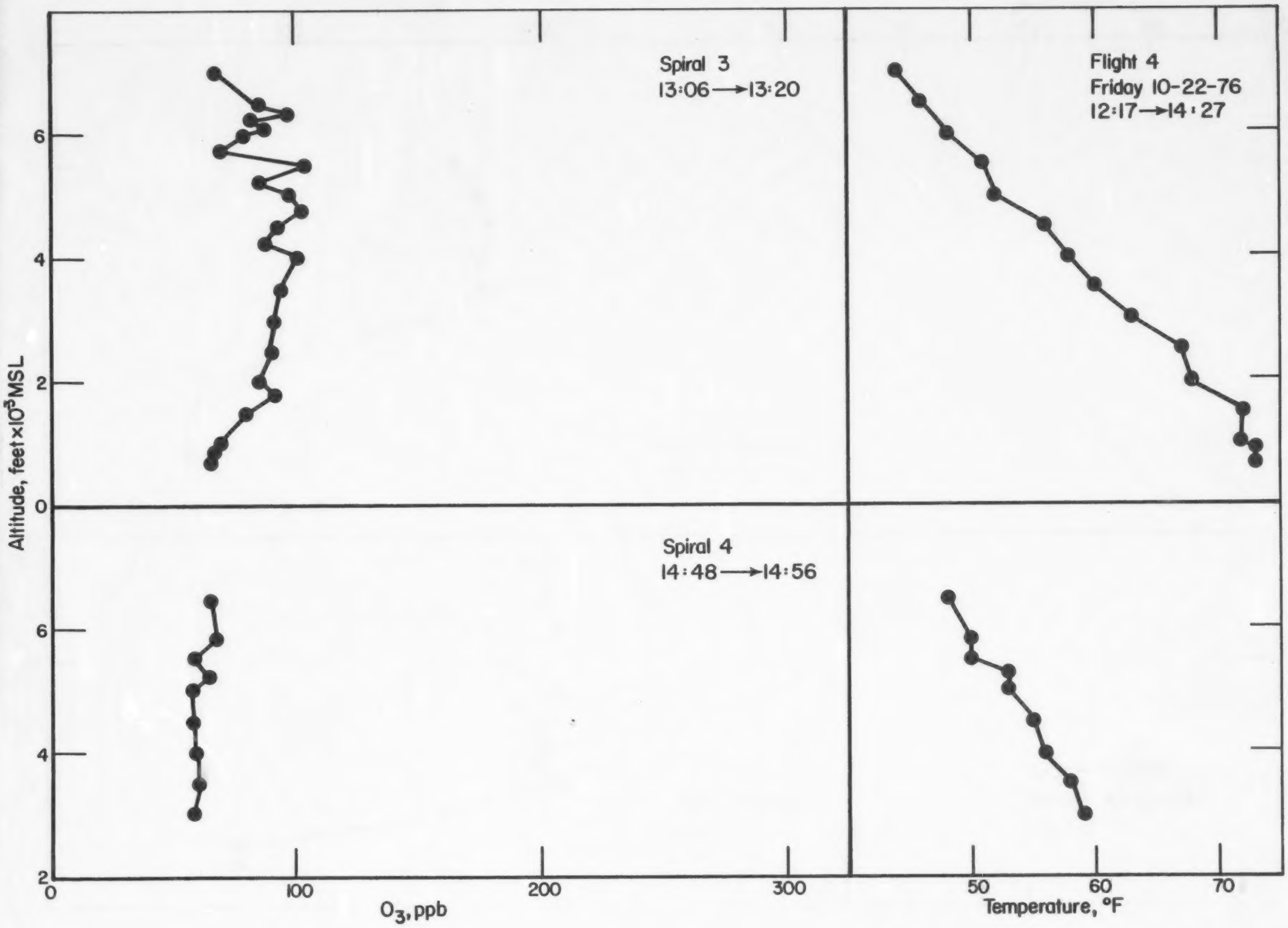
A→B 100 ft above water
C→D 200 ft above water

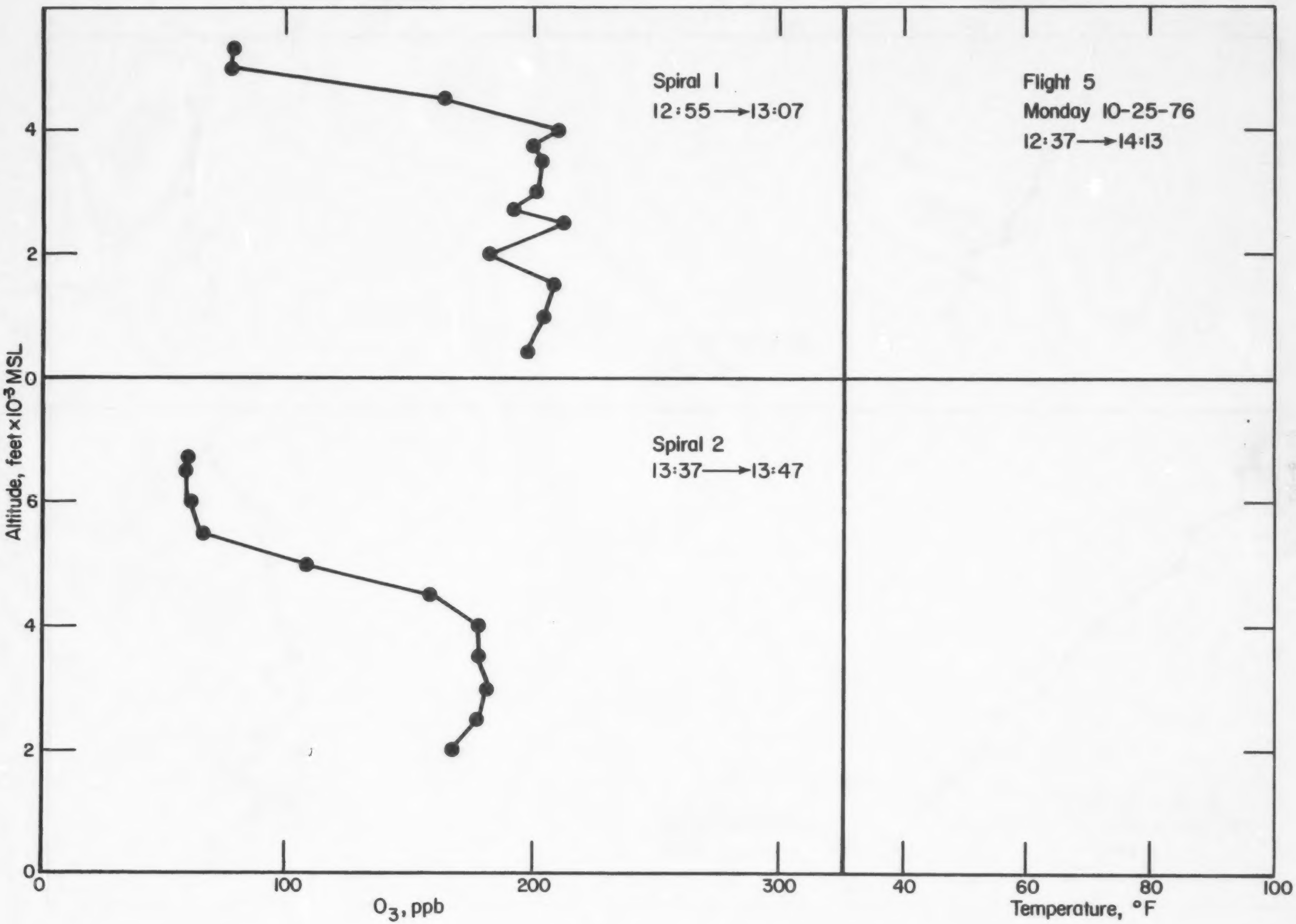

Spiral
12:14—12:23
Flight 1
Wednesday 10-20-76
11:55—12:41
Altitude, feet×10³MSL
6
4
2
0
4
2
0
0
100
200
300
O₃,ppb
40
60
80
100
Temperature, °F

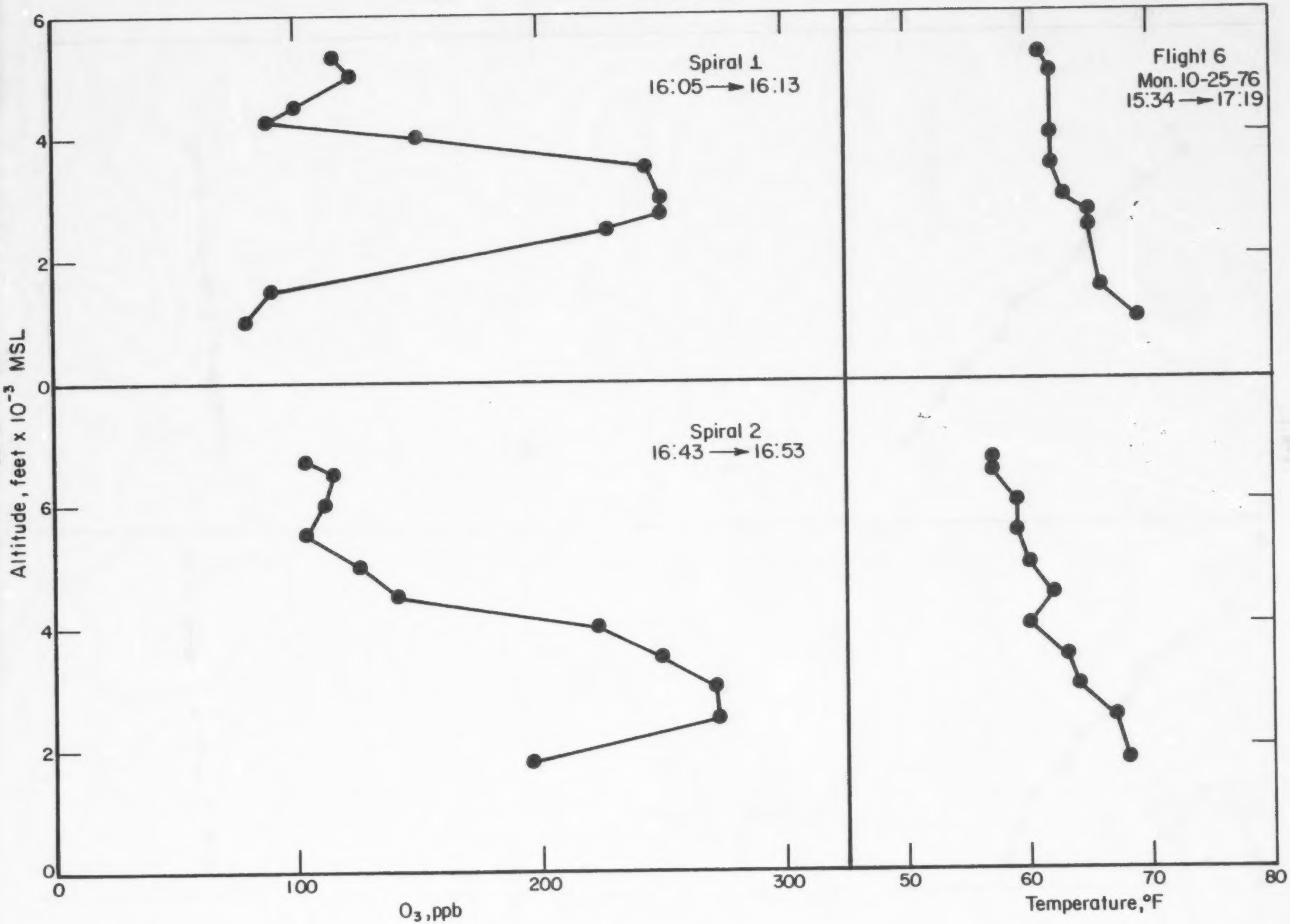

Spiral 1
13:40→13:47
Flight 2
Thursday 10-21-76
13:11→14:44
Spiral 2
14:17→14:22
Altitude, feet × 10⁻³ MSL
0
2
4
6
0
2
4
0
100
200
300
O₃, ppb
40
60
80
100
Temperature, °F

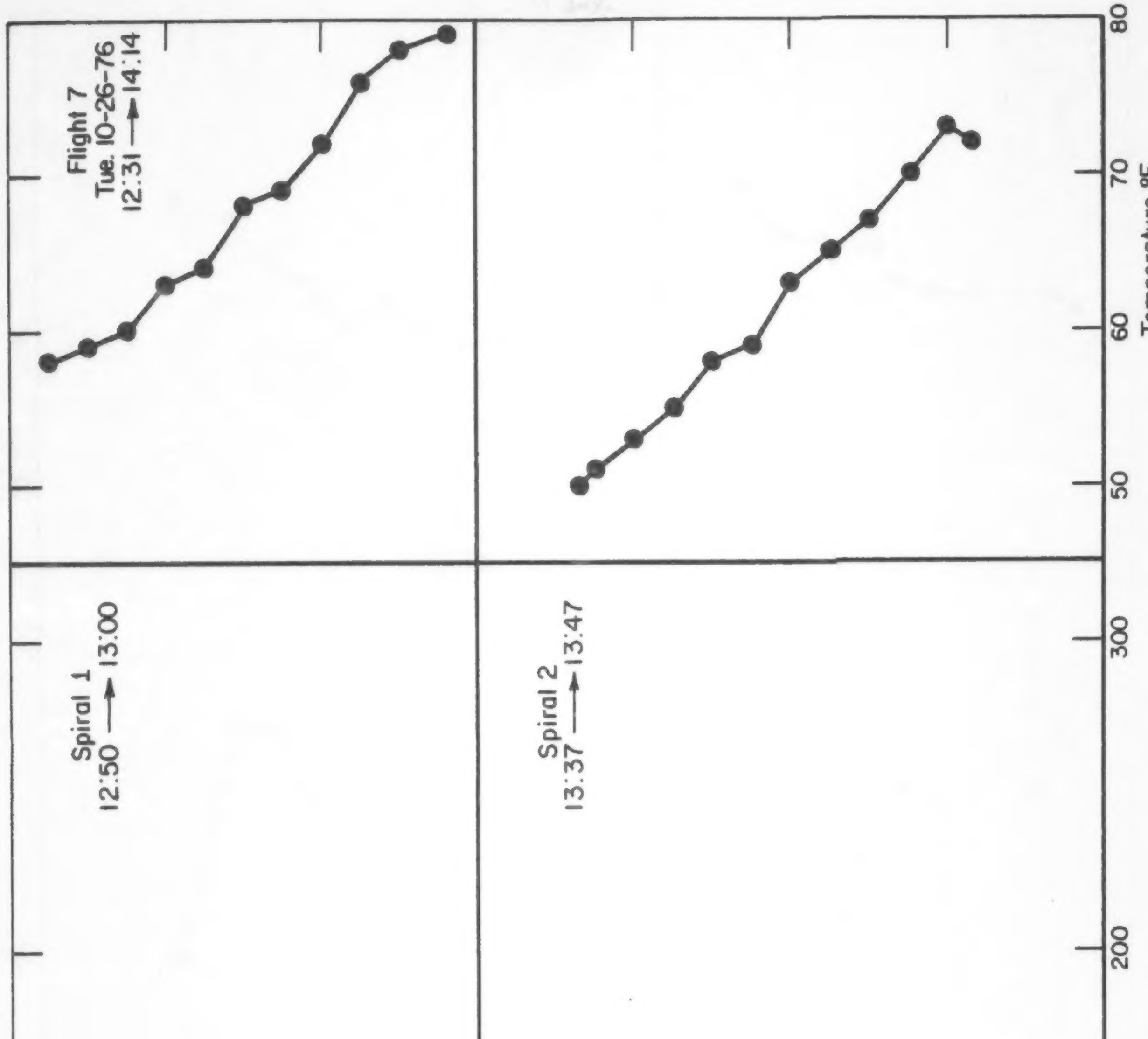

Flight 3
Thur. 10-21-76
16:30→18:01
Spiral 1
16:56→17:04
Spiral 2
17:27→17:40
Altitude, feet x 10^{-3} MSL
0
2
4
6
O$_3$, ppb
0
100
200
300
Temperature, °F
40
60
80
100

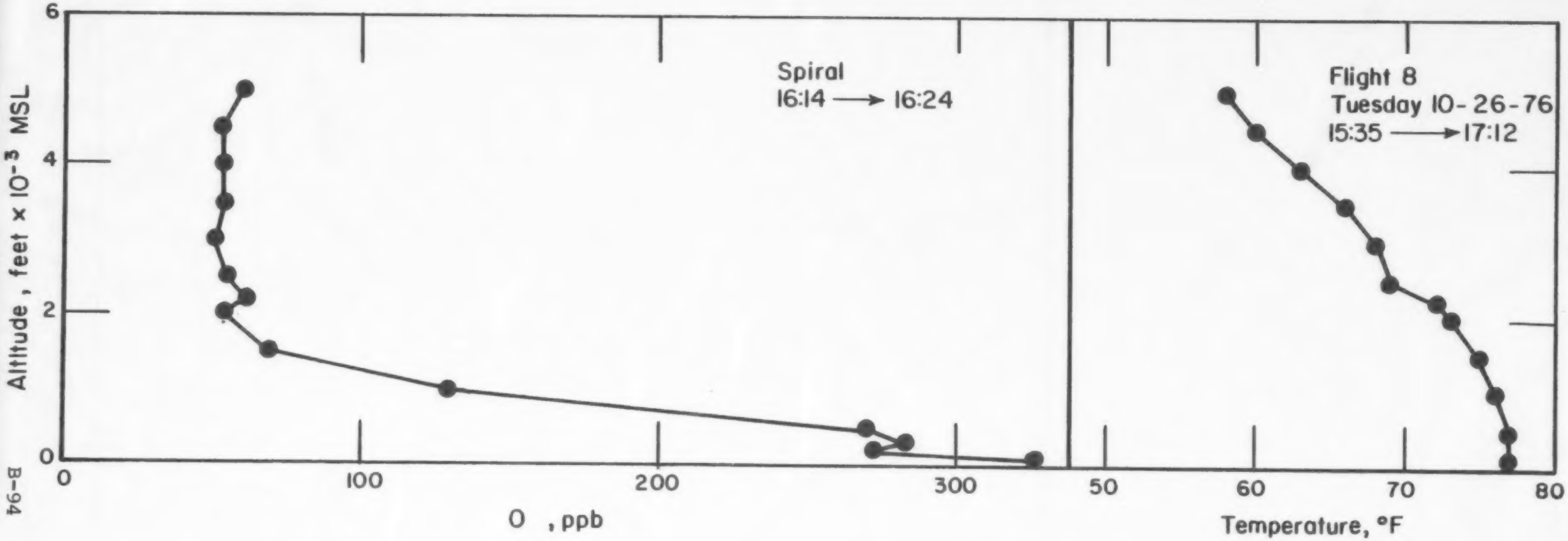
Spiral 1
12:24→12:33
Flight 4
Friday 10-22-76
12:17→14:27
Spiral 2
12:48→12:58
Altitude, feet × 10^3 MSL
8
6
4
8
6
4
2
0
100
200
300
O_3, ppb
40
50
60
70
Temperature, °F

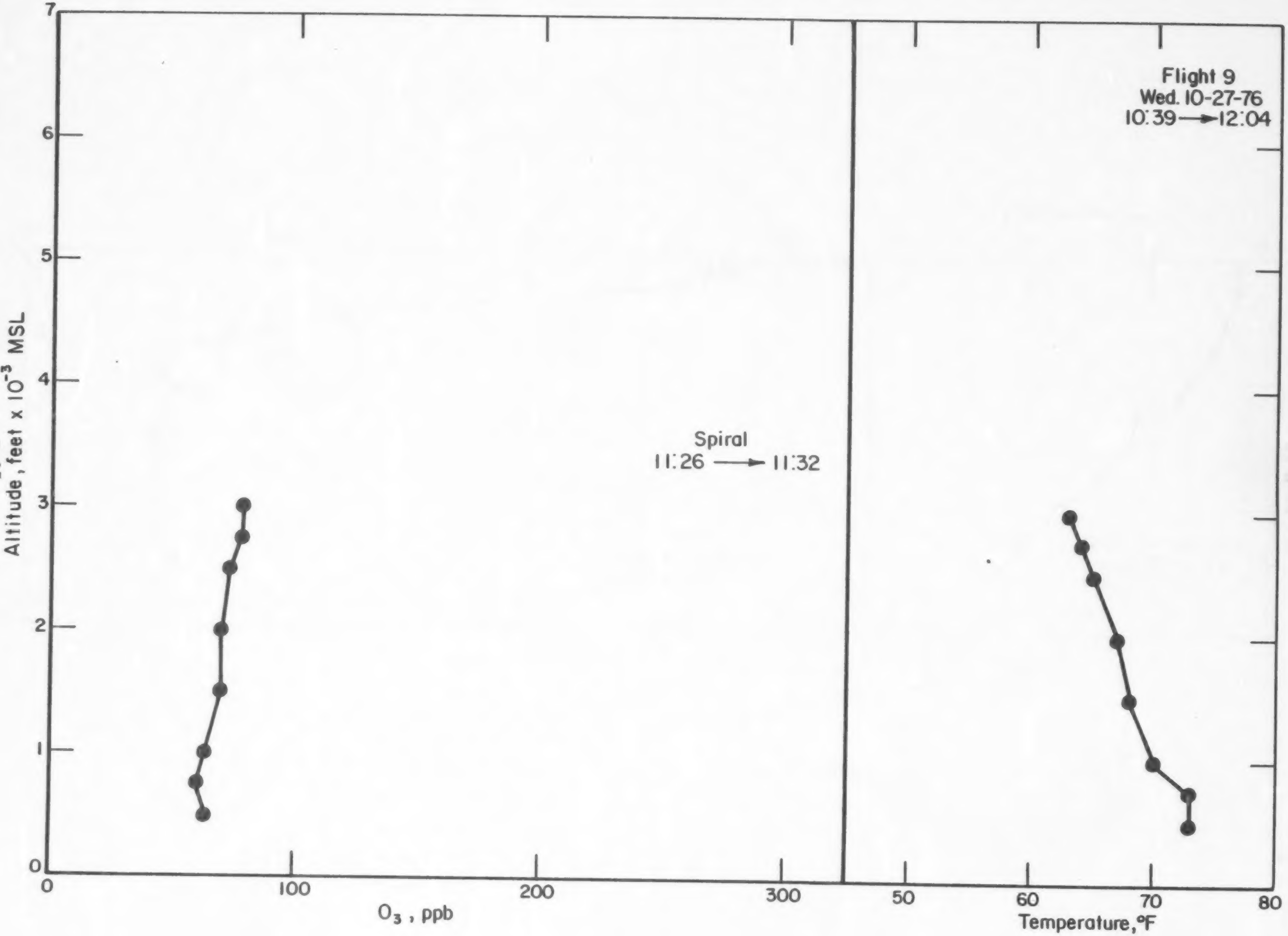

Spiral 3
13:06 → 13:20
Flight 4
Friday 10-22-76
12:17 → 14:27
Spiral 4
14:48 → 14:56
Altitude, feet × 10³ MSL
0
2
4
6
0
100
200
300
O₃, ppb
50
60
70
Temperature, °F

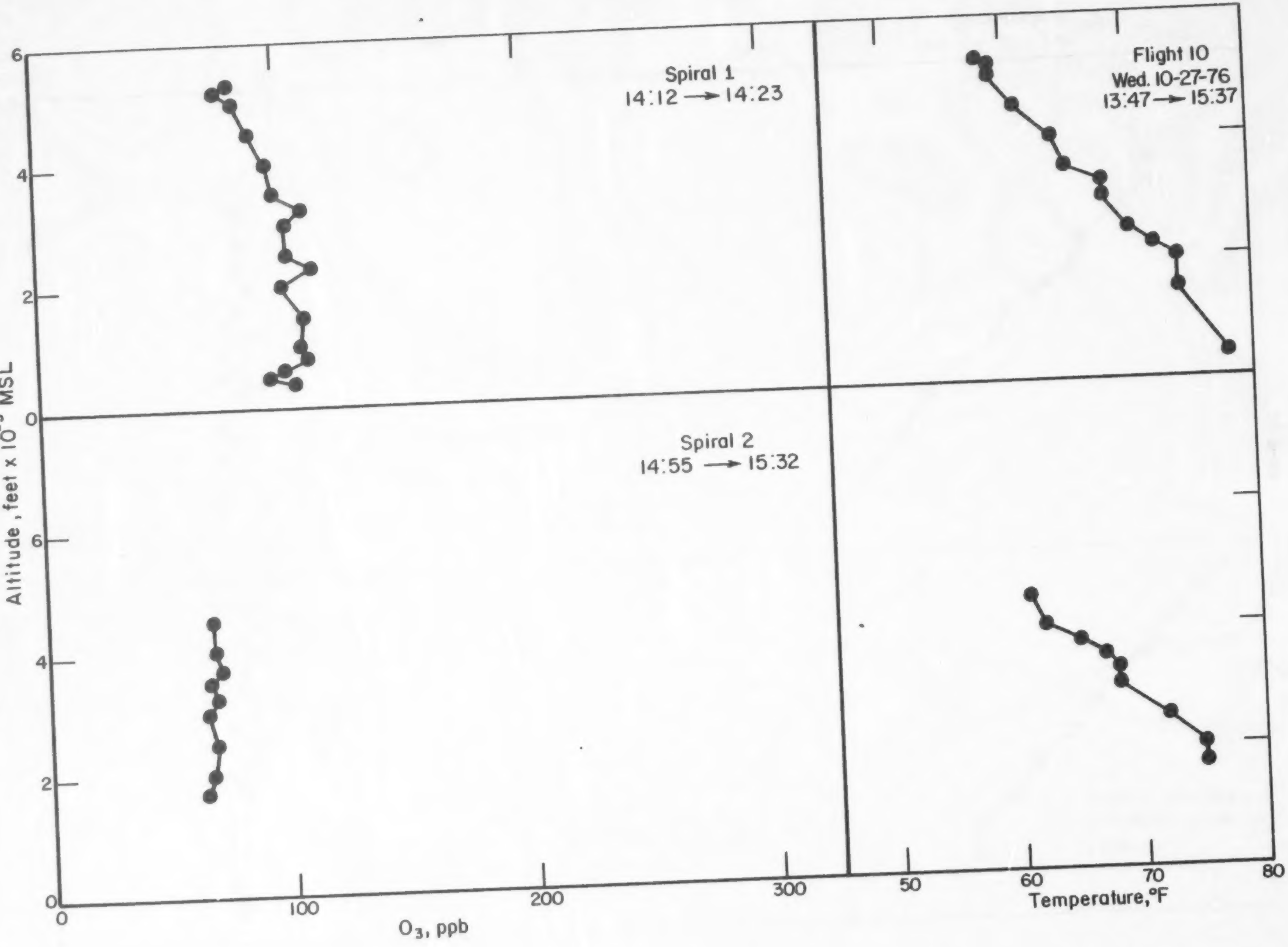

Spiral 1
12:55 ⟶ 13:07
Spiral 2
13:37 ⟶ 13:47
Flight 5
Monday 10-25-76
12:37 ⟶ 14:13
Altitude, feet × 10³ MSL
0
2
4
6
O₃, ppb
100
200
300
Temperature, °F
40
60
80
100

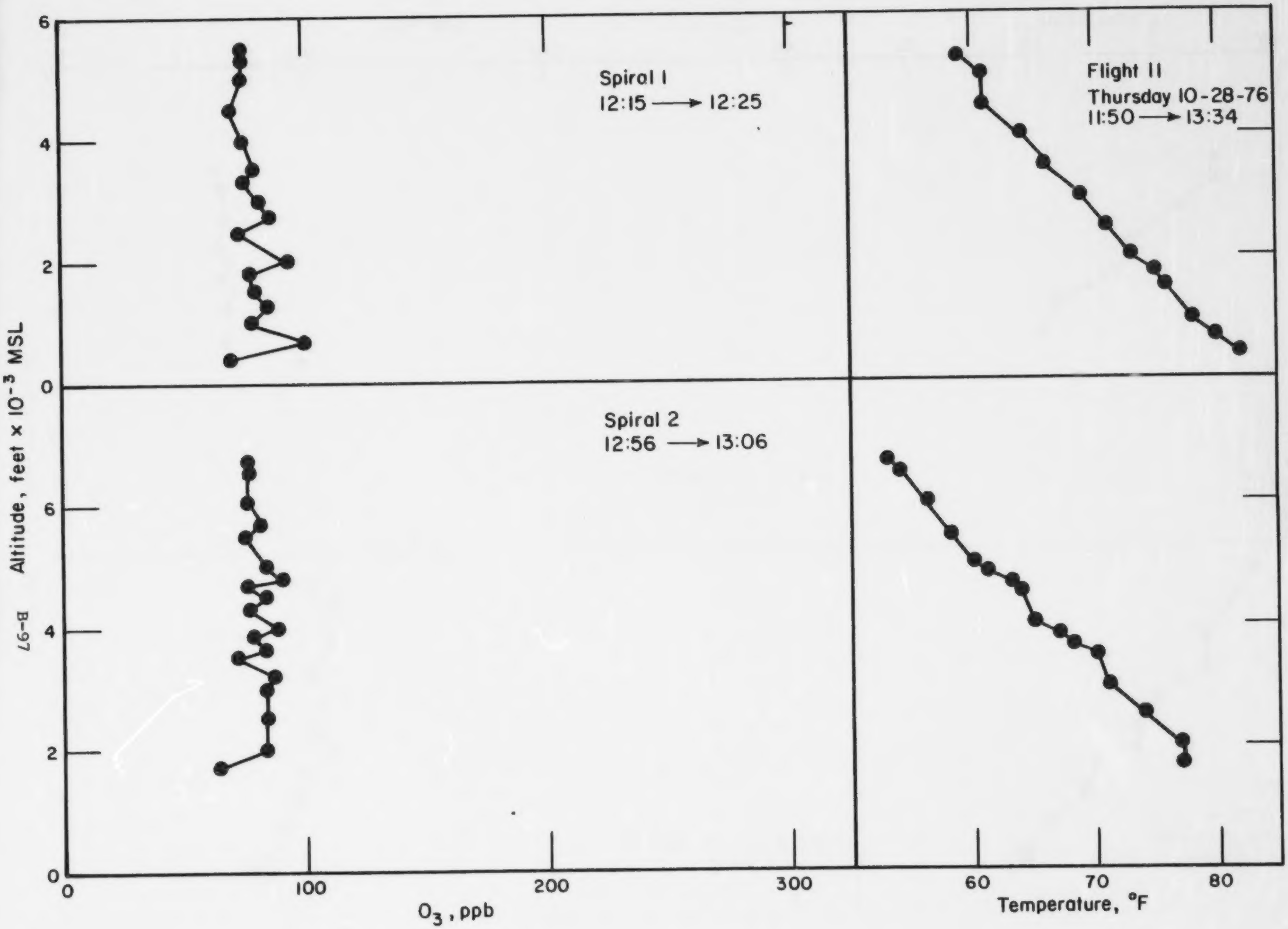

Spiral 1
16:05 → 16:13
Spiral 2
16:43 → 16:53
Flight 6
Mon. 10-25-76
15:34 → 17:19
Altitude, feet x 10^{-3} MSL
6
4
2
0
6
4
2
0
0
100
200
300
O$_3$, ppb
50
60
70
80
Temperature, °F

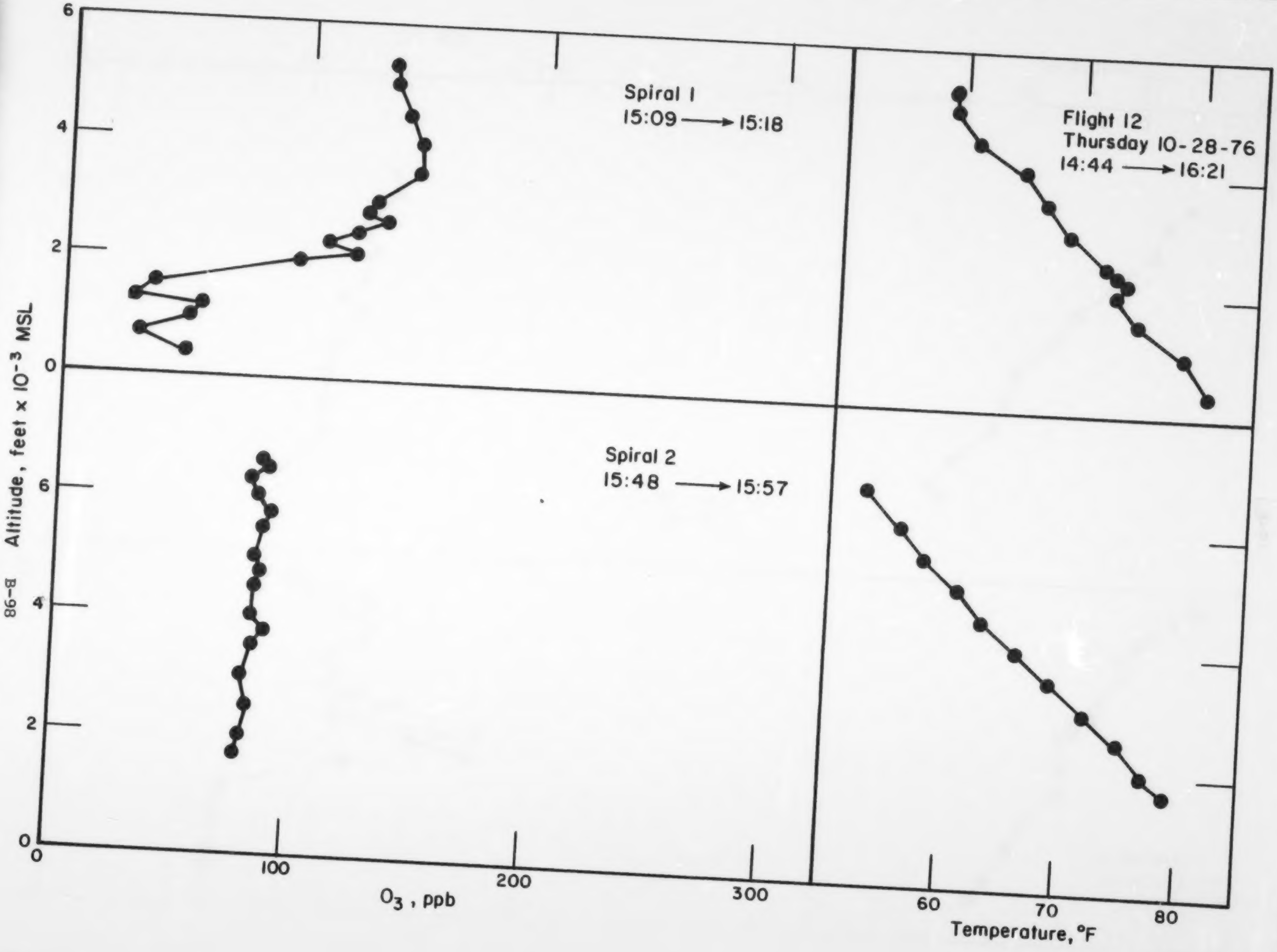

Flight 7
Tue. 10-26-76
12:31 → 14:14
Spiral 1
12:50 → 13:00
Spiral 2
13:37 → 13:47
0
100
200
300
O_3, ppb
50
60
70
80
Temperature, °F
0
2
4
6
0
2
4
6
Altitude, feet x 10^{-3} MSL

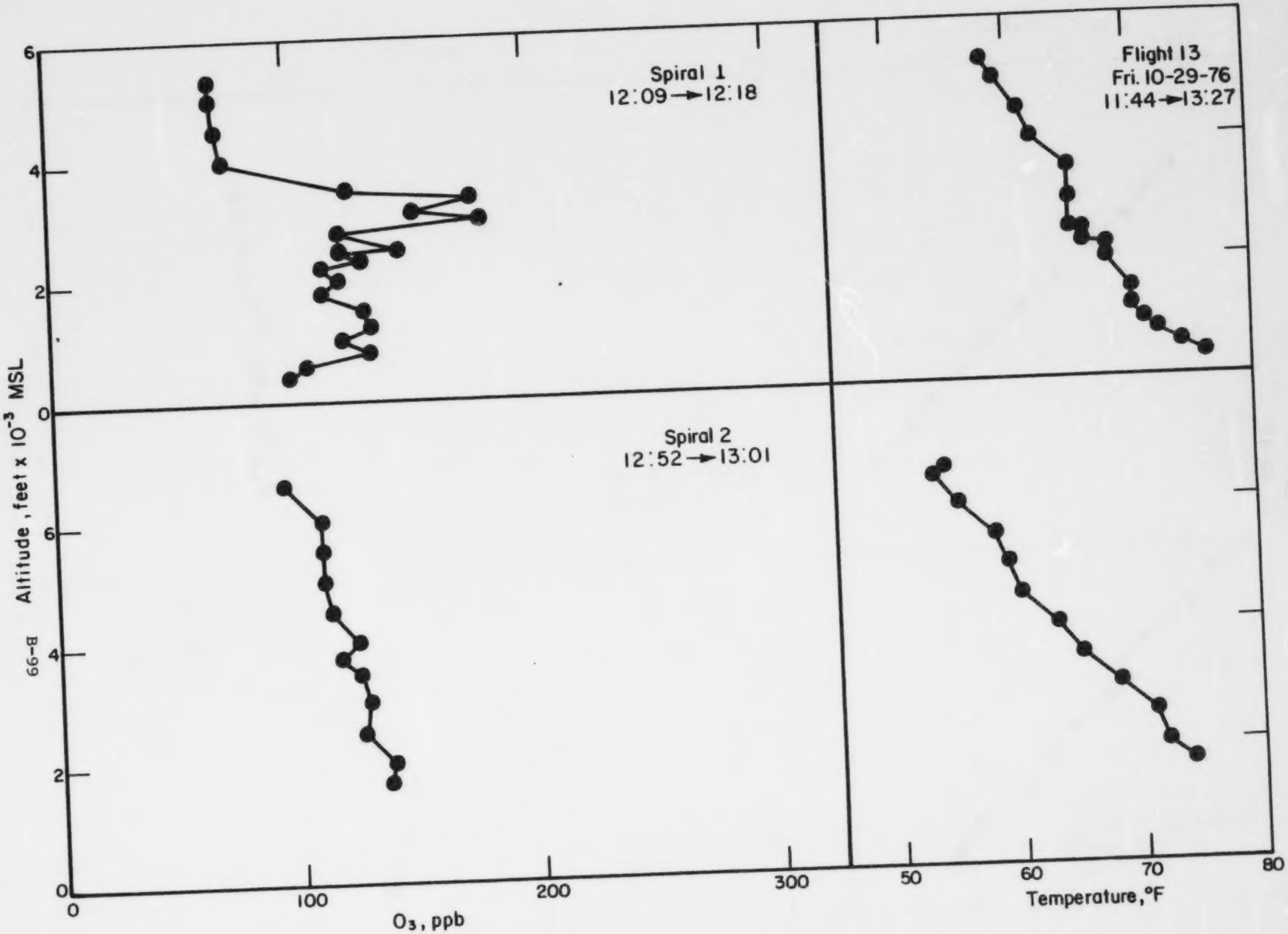
Spiral
16:14 ⟶ 16:24
Flight 8
Tuesday 10-26-76
15:35 ⟶ 17:12
Altitude, feet × 10⁻³ MSL
0
2
4
6
0
100
200
300
O , ppb
50
60
70
80
Temperature, °F

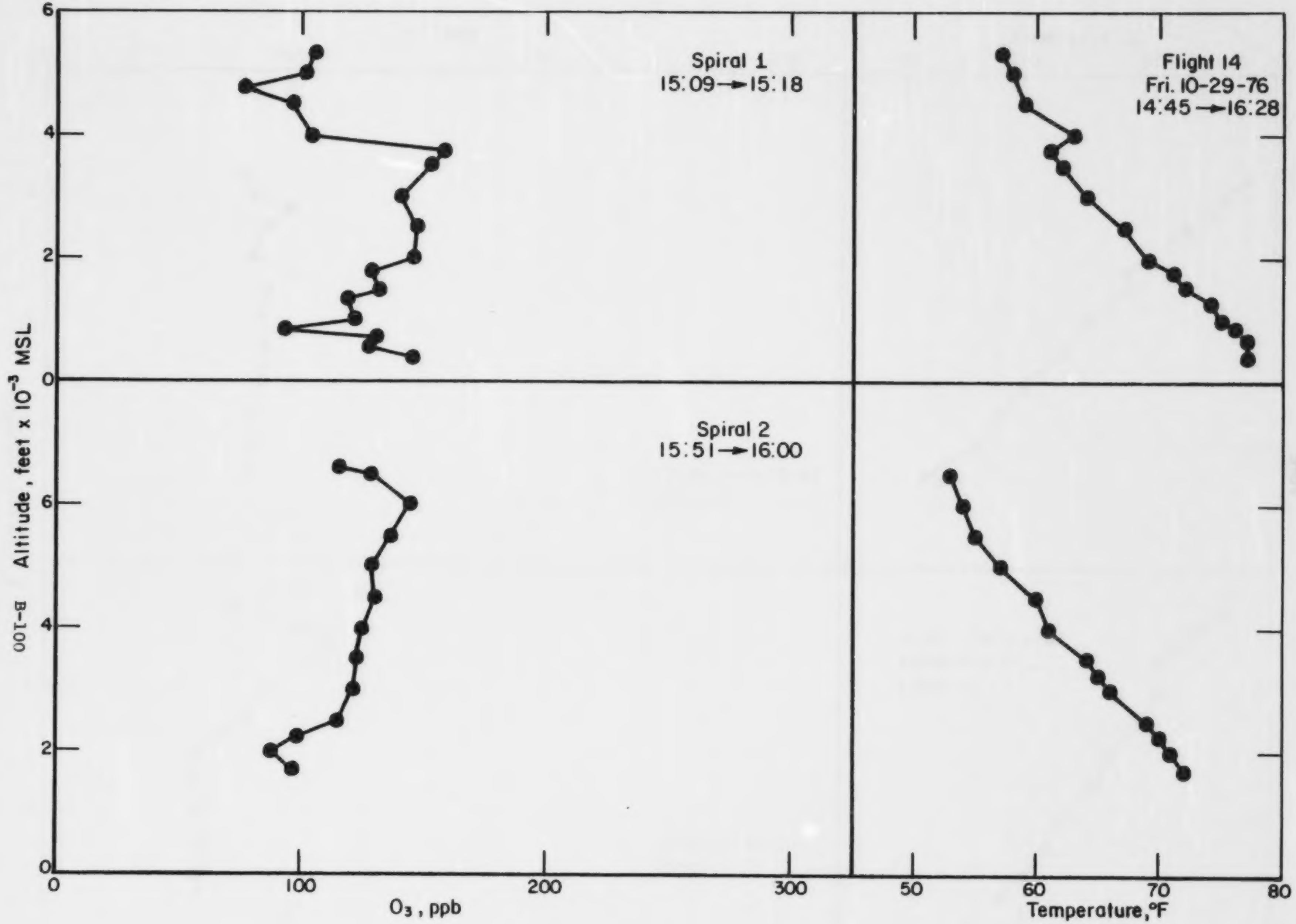

Flight 9
Wed. 10-27-76
10:39 → 12:04
Spiral
11:26 → 11:32
Altitude, feet x 10^{-3} MSL
0
1
2
3
4
5
6
7
0
100
200
300
O_3, ppb
50
60
70
80
Temperature, °F


Flight 10
Wed. 10-27-76
13:47 → 15:37
Spiral 1
14:12 → 14:23
Spiral 2
14:55 → 15:32
Altitude, feet x 10^{-3} MSL
6
4
2
0
6
4
2
0
0
100
200
300
O_3, ppb
50
60
70
80
Temperature, °F

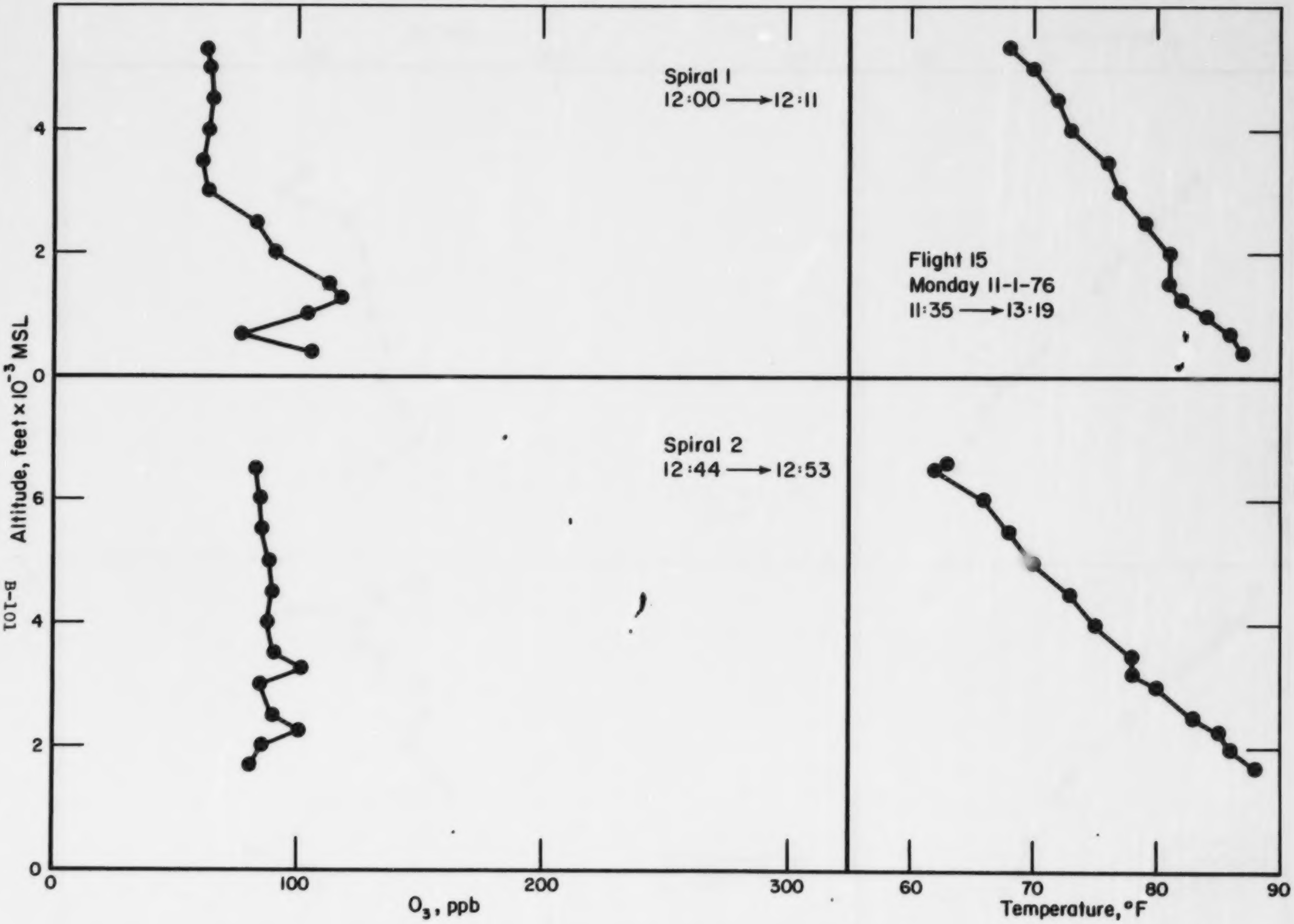

Spiral 1
12:15 → 12:25
Spiral 2
12:56 → 13:06
Flight 11
Thursday 10-28-76
11:50 → 13:34
Altitude, feet × 10⁻³ MSL
0
2
4
6
0
2
4
6
0
100
200
300
O3 , ppb
60
70
80
Temperature, °F

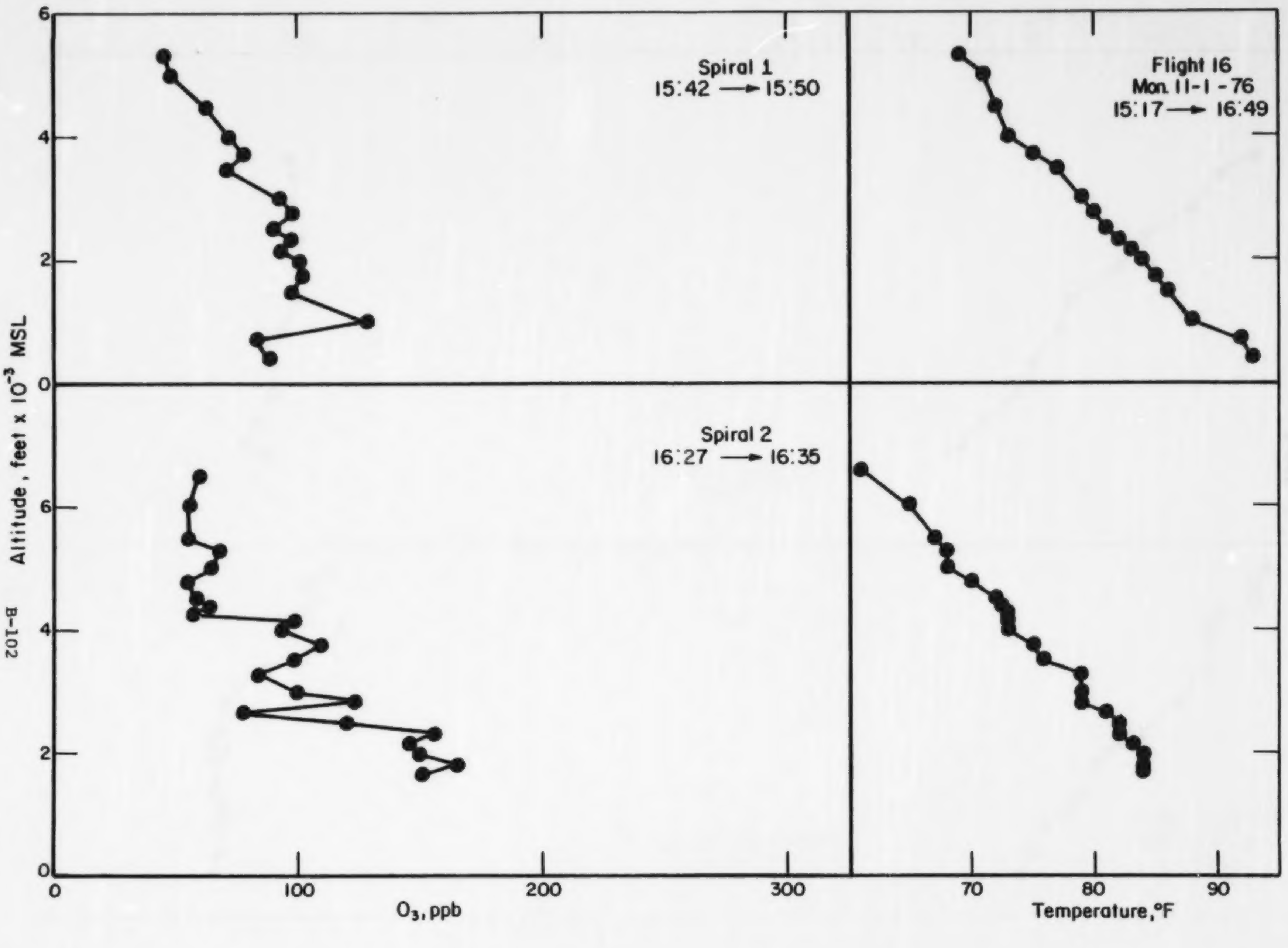

Spiral 1
15:09 → 15:18
Spiral 2
15:48 → 15:57
Flight 12
Thursday 10-28-76
14:44 → 16:21
Altitude, feet x 10^{-3} MSL
0
2
4
6
0
2
4
6
0
100
200
300
O_3 , ppb
60
70
80
Temperature, °F

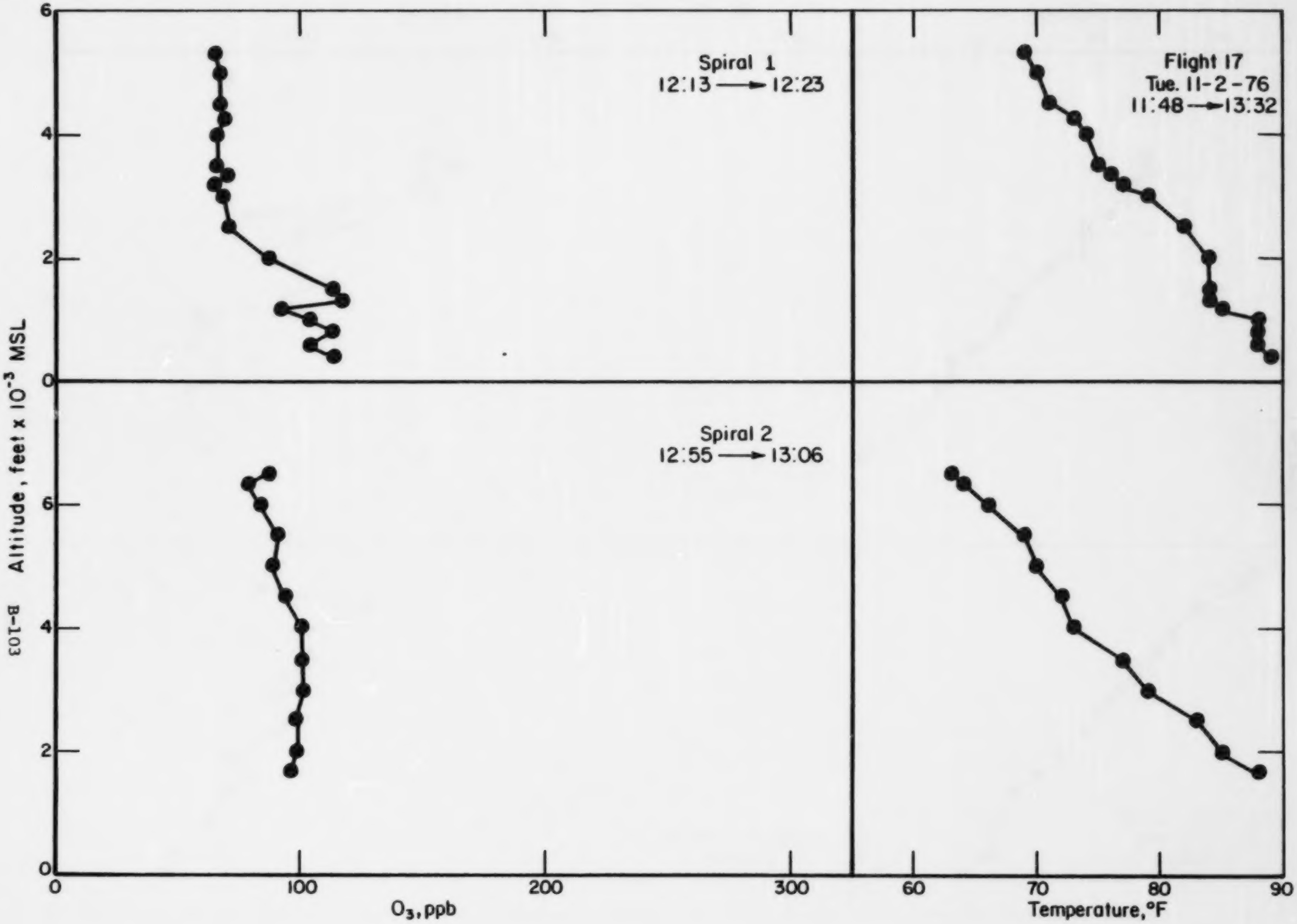

Spiral 1
12:09→12:18
Spiral 2
12:52→13:01
Flight 13
Fri. 10-29-76
11:44→13:27
Altitude, feet x 10⁻³ MSL
0
2
4
6
0
2
4
6
0
100
200
300
O₃, ppb
50
60
70
80
Temperature, °F

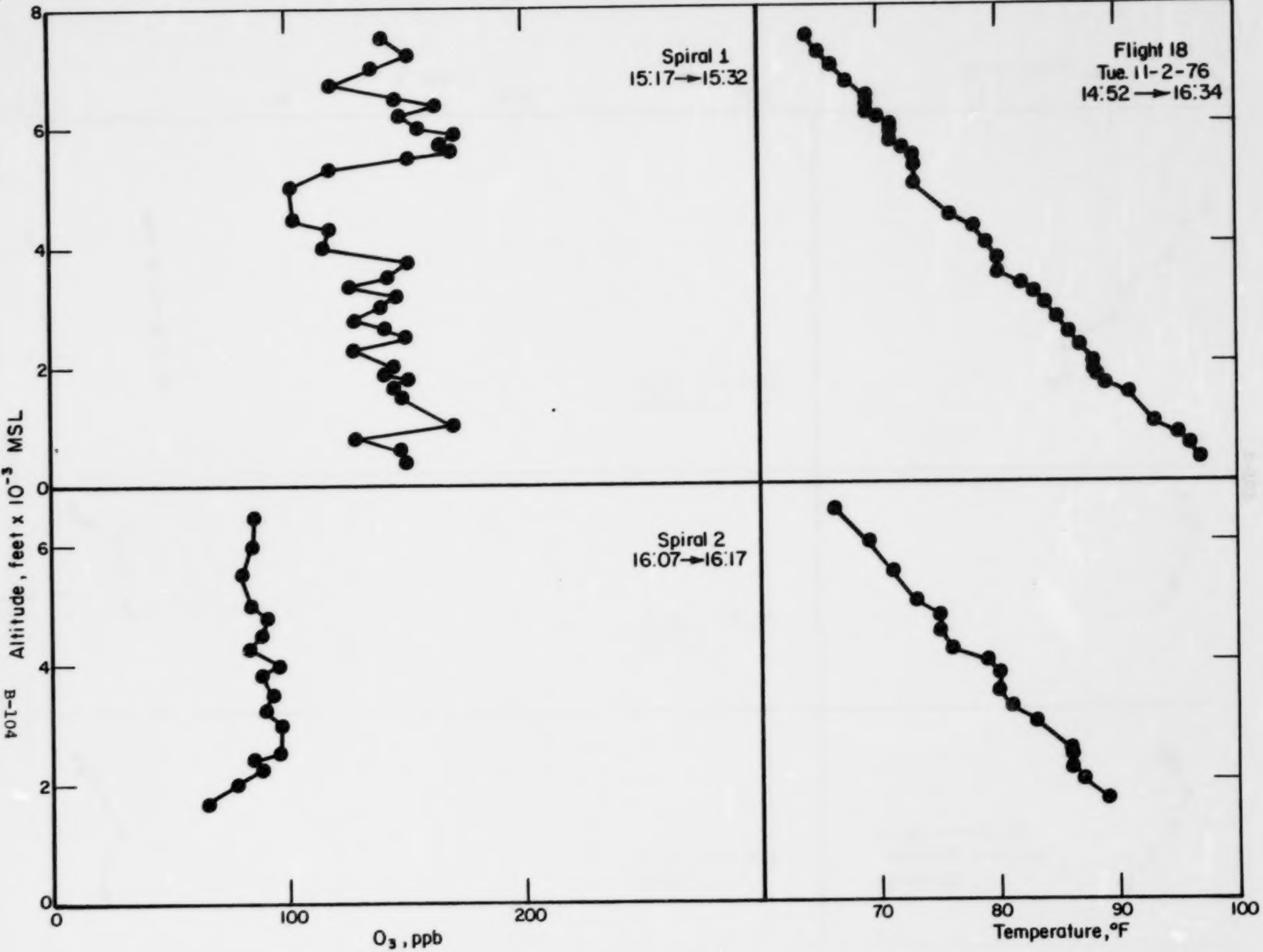

Spiral 1
15:09→15:18
Spiral 2
15:51→16:00
Flight 14
Fri. 10-29-76
14:45→16:28
Altitude, feet x 10^{-3} MSL
6
4
2
0
6
4
2
0
0
100
200
300
O_3, ppb
50
60
70
80
Temperature, °F

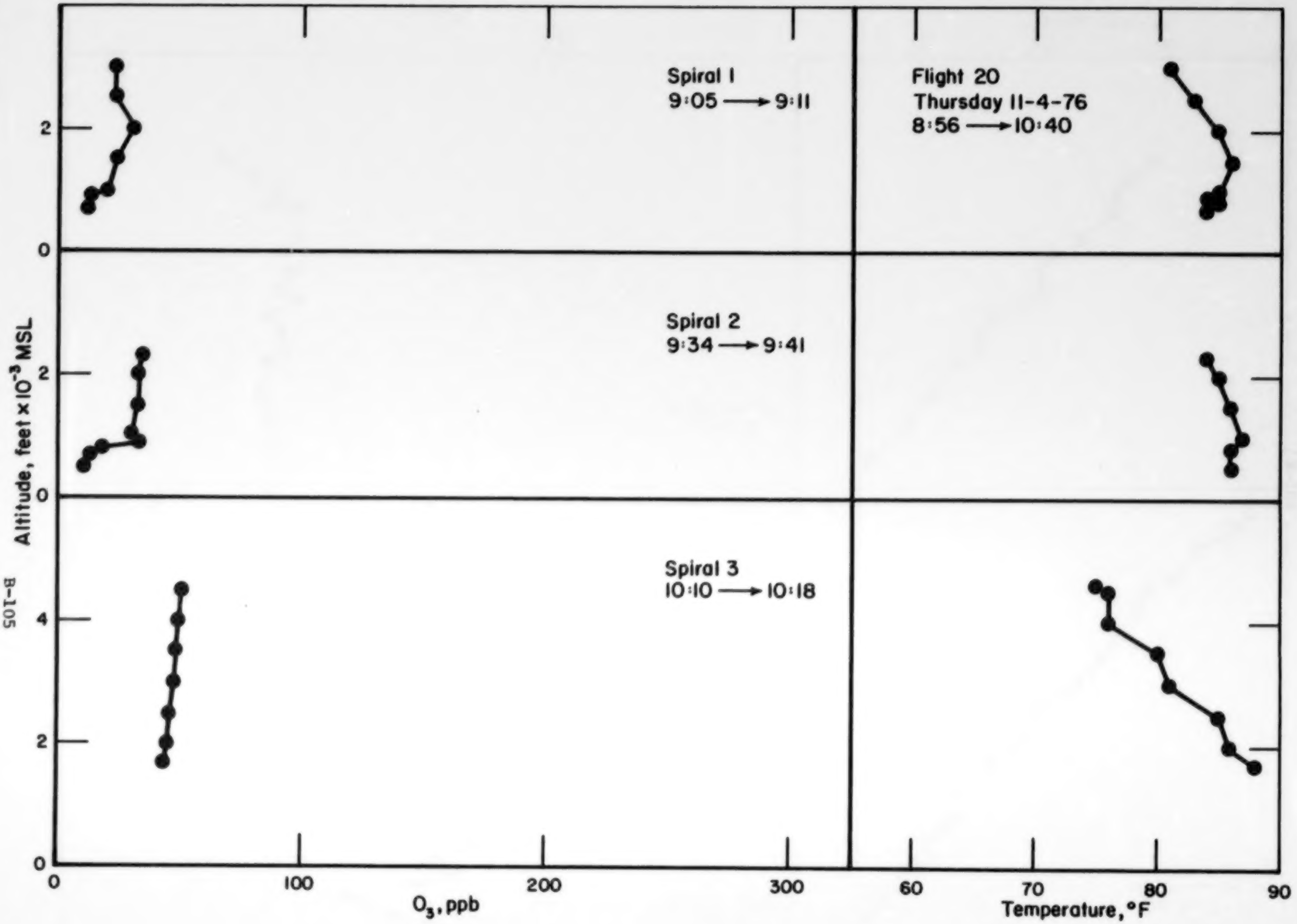
B-100

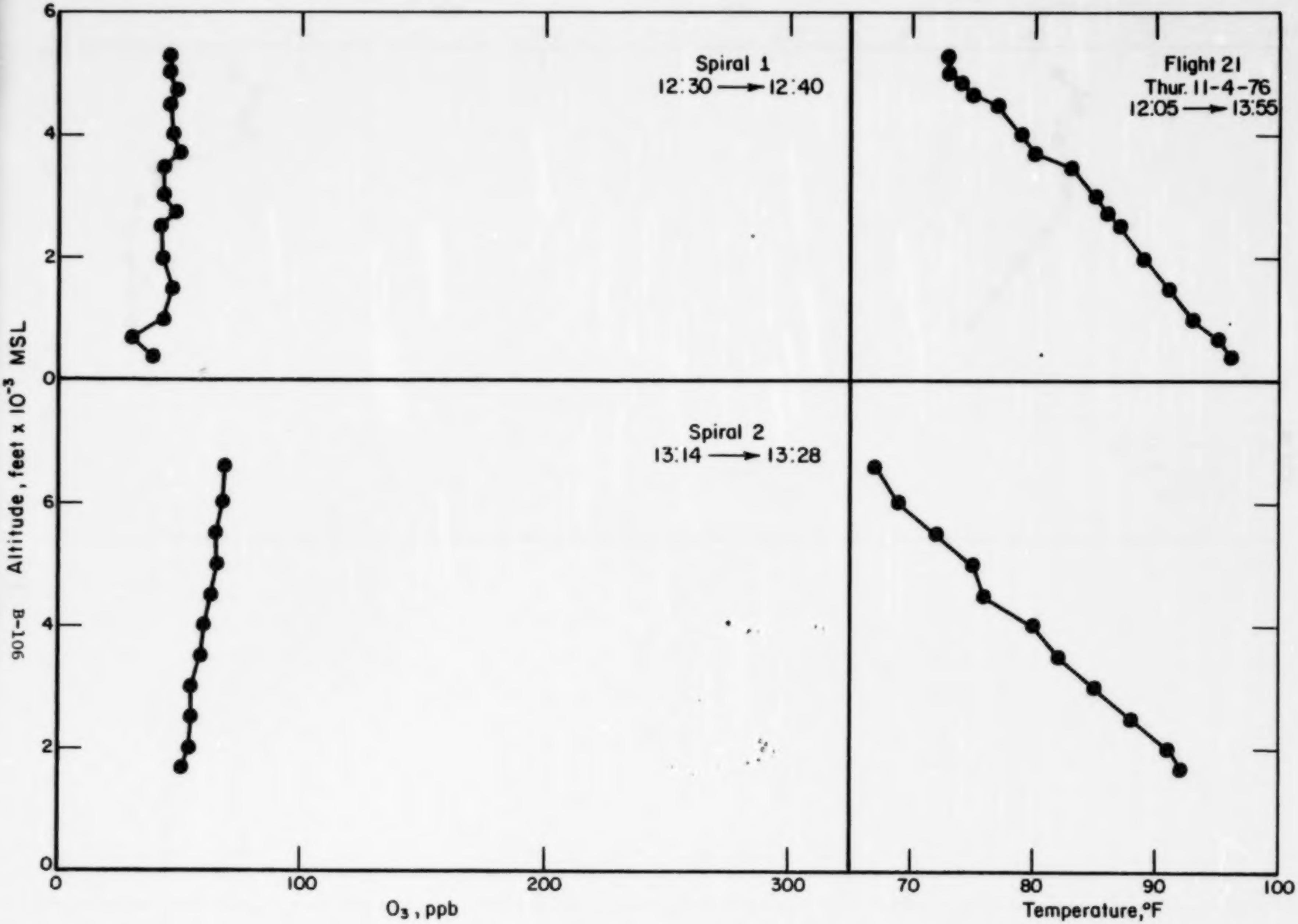

Spiral 1
12:00 ⟶ 12:11
Spiral 2
12:44 ⟶ 12:53
Flight 15
Monday 11-1-76
11:35 ⟶ 13:19
Altitude, feet × 10^{-3} MSL
0
2
4
6
100
200
300
O_3, ppb
60
70
80
90
Temperature, °F

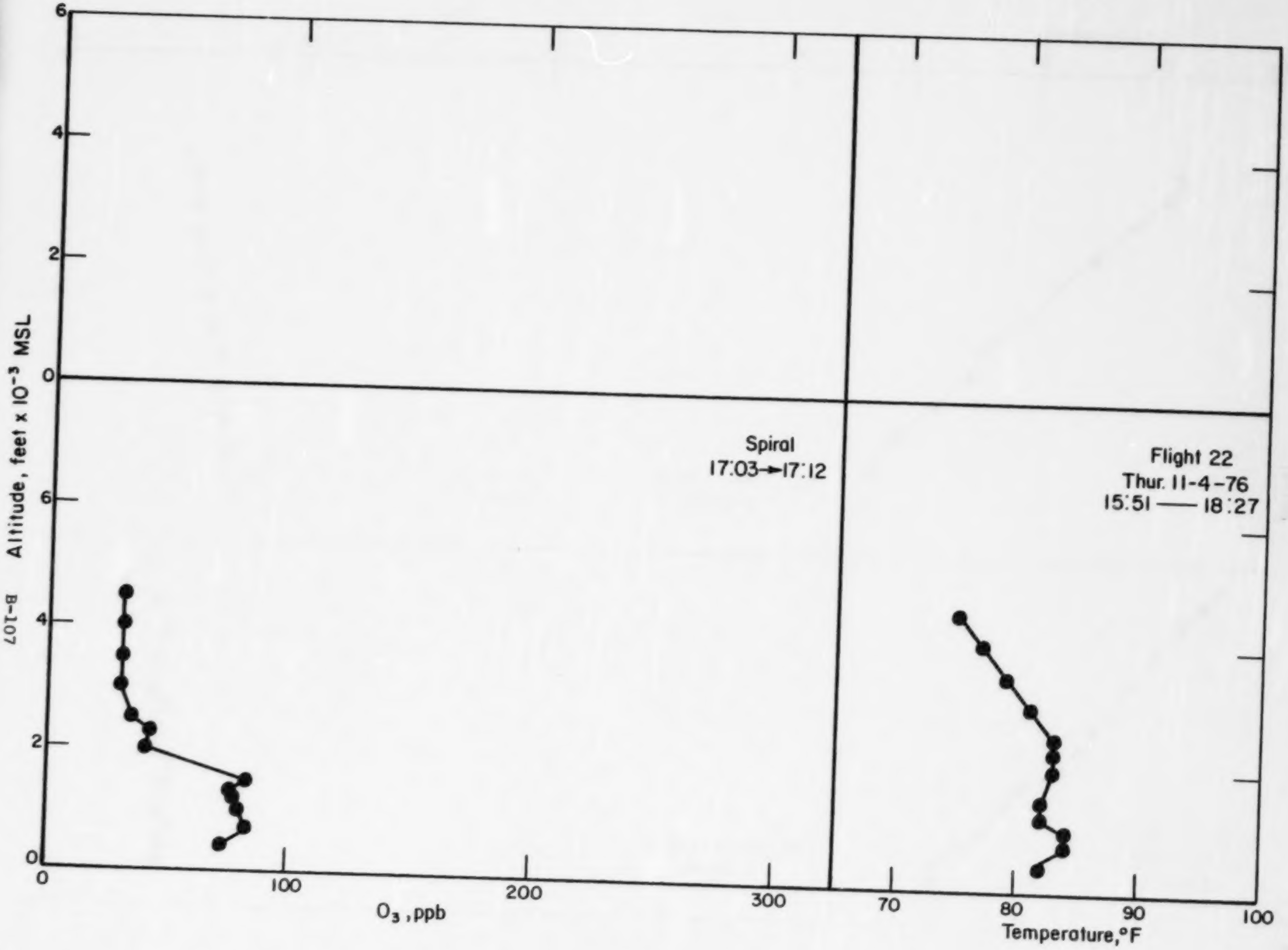

Spiral 1
15:42 ⟶ 15:50
Spiral 2
16:27 ⟶ 16:35
Flight 16
Mon. 11-1-76
15:17 ⟶ 16:49
Altitude, feet x 10^{-3} MSL
6
4
2
0
6
4
2
0
0
100
200
300
O$_3$, ppb
70
80
90
Temperature, °F

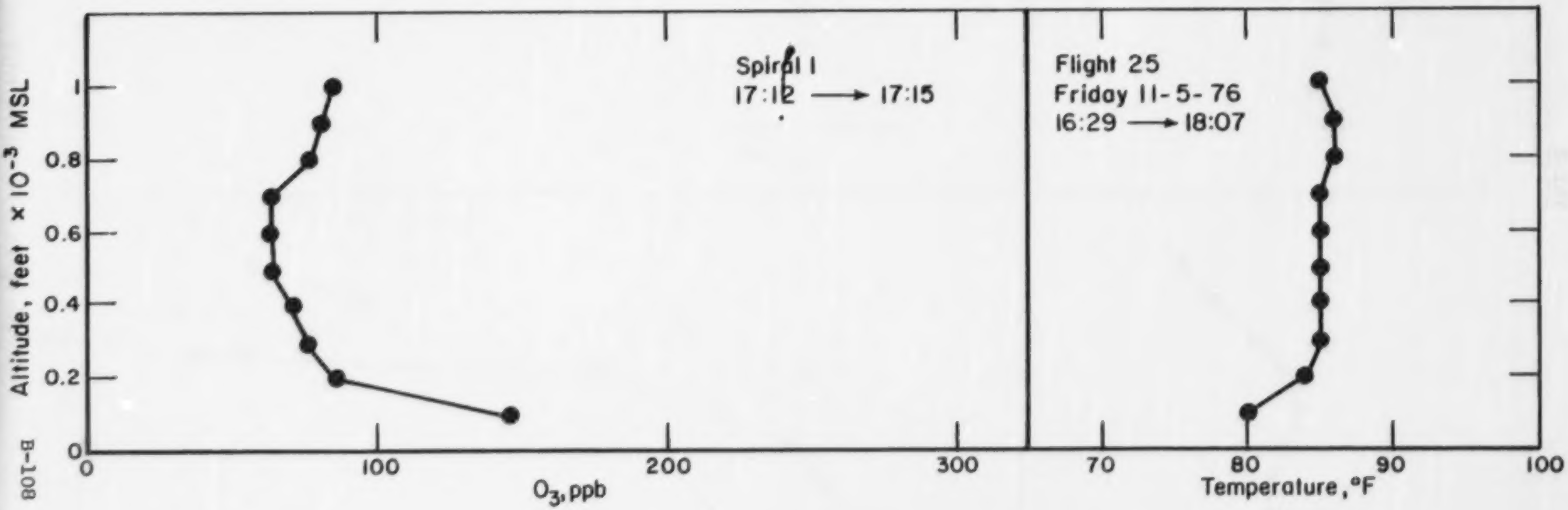

Spiral 1
12:13 ⟶ 12:23
Spiral 2
12:55 ⟶ 13:06
Flight 17
Tue. 11-2-76
11:48 ⟶ 13:32
Altitude, feet x 10^{-3} MSL
6
4
2
0
6
4
2
0
0
100
200
300
O$_3$, ppb
60
70
80
90
Temperature, °F

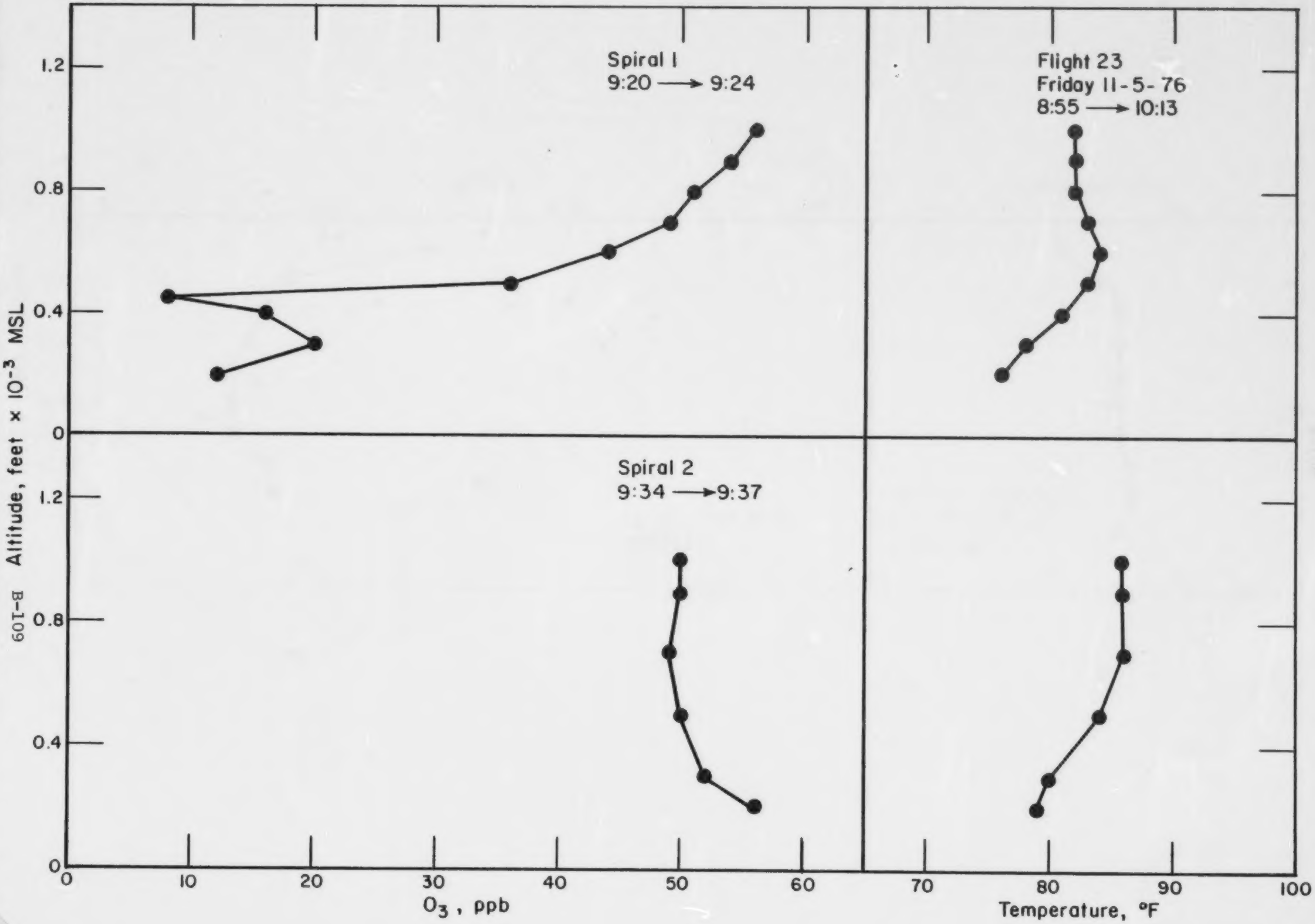

Spiral 1
15:17→15:32
Flight 18
Tue. 11-2-76
14:52→16:34
Spiral 2
16:07→16:17
Altitude, feet x 10^{-3} MSL
0
2
4
6
8
0
100
200
O$_3$, ppb
70
80
90
100
Temperature, °F

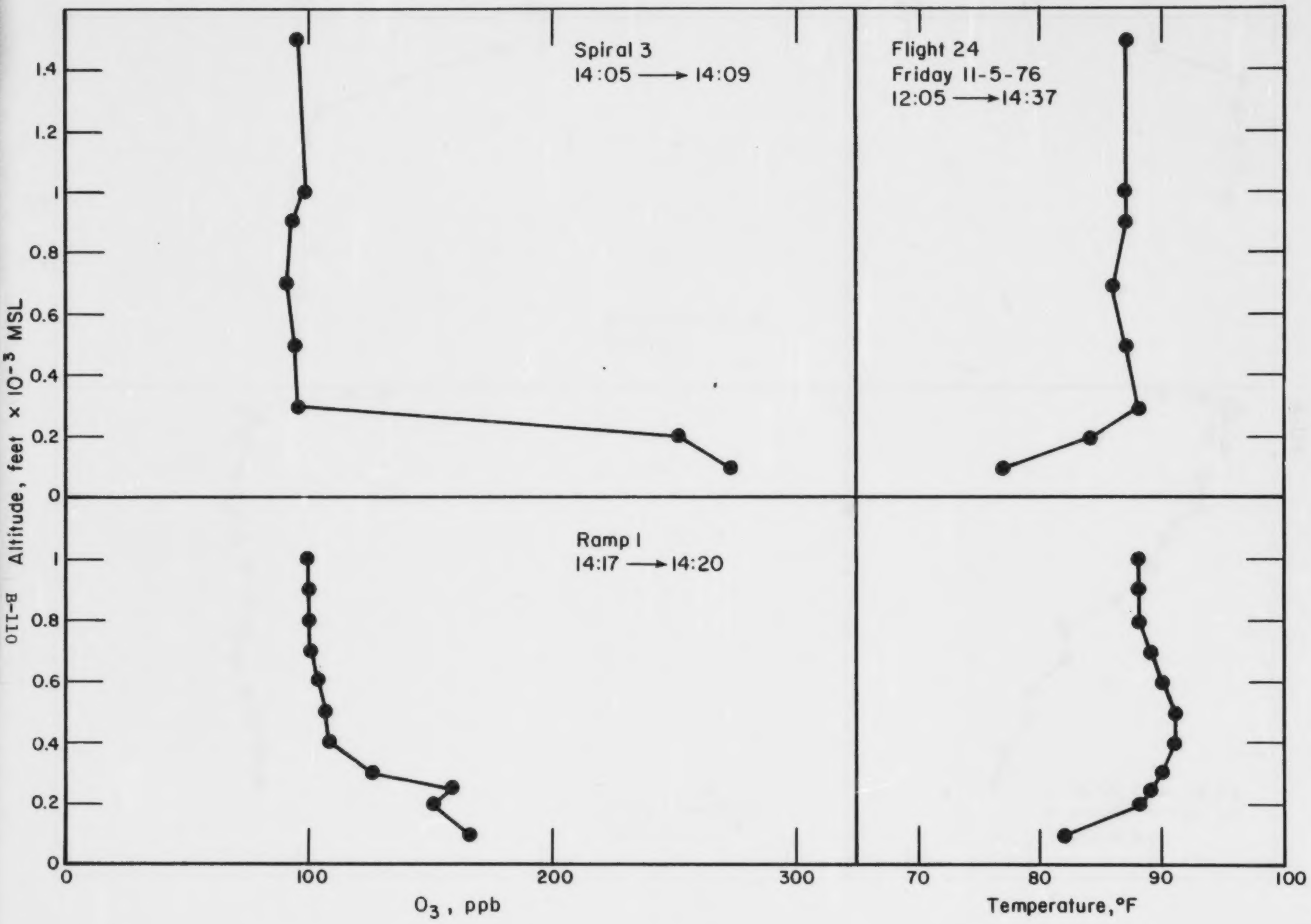

Spiral 1
9:05 ⟶ 9:11
Spiral 2
9:34 ⟶ 9:41
Spiral 3
10:10 ⟶ 10:18
Flight 20
Thursday 11-4-76
8:56 ⟶ 10:40
Altitude, feet × 10⁻³ MSL
0
2
0
2
0
2
4
0
100
200
300
O₃, ppb
60
70
80
90
Temperature, °F

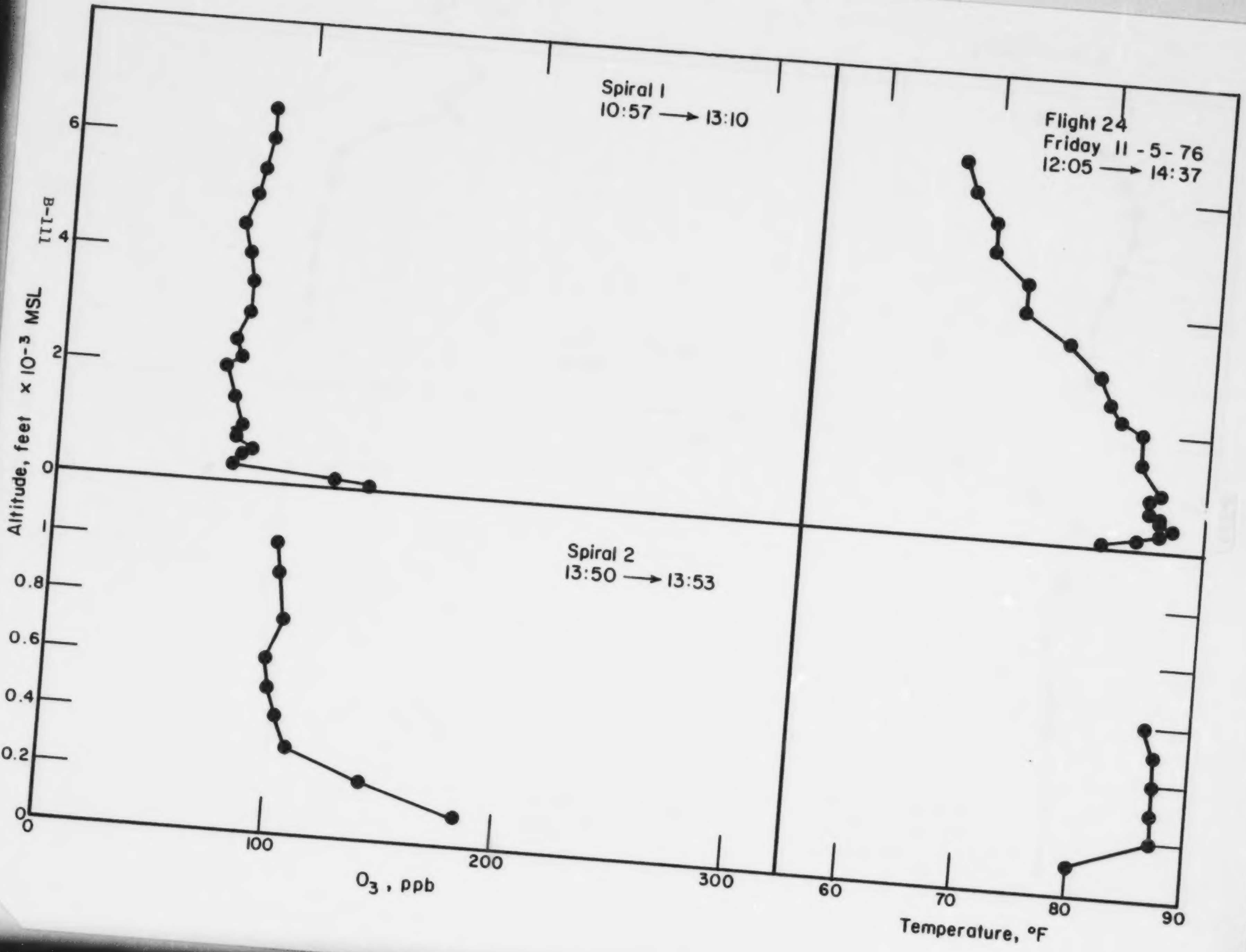

Spiral 1
12:30 ⟶ 12:40
Flight 21
Thur. 11-4-76
12:05 ⟶ 13:55
Spiral 2
13:14 ⟶ 13:28
Altitude, feet x 10⁻³ MSL
6
4
2
0
6
4
2
0
0
100
200
300
70
80
90
100
O₃, ppb
Temperature, °F

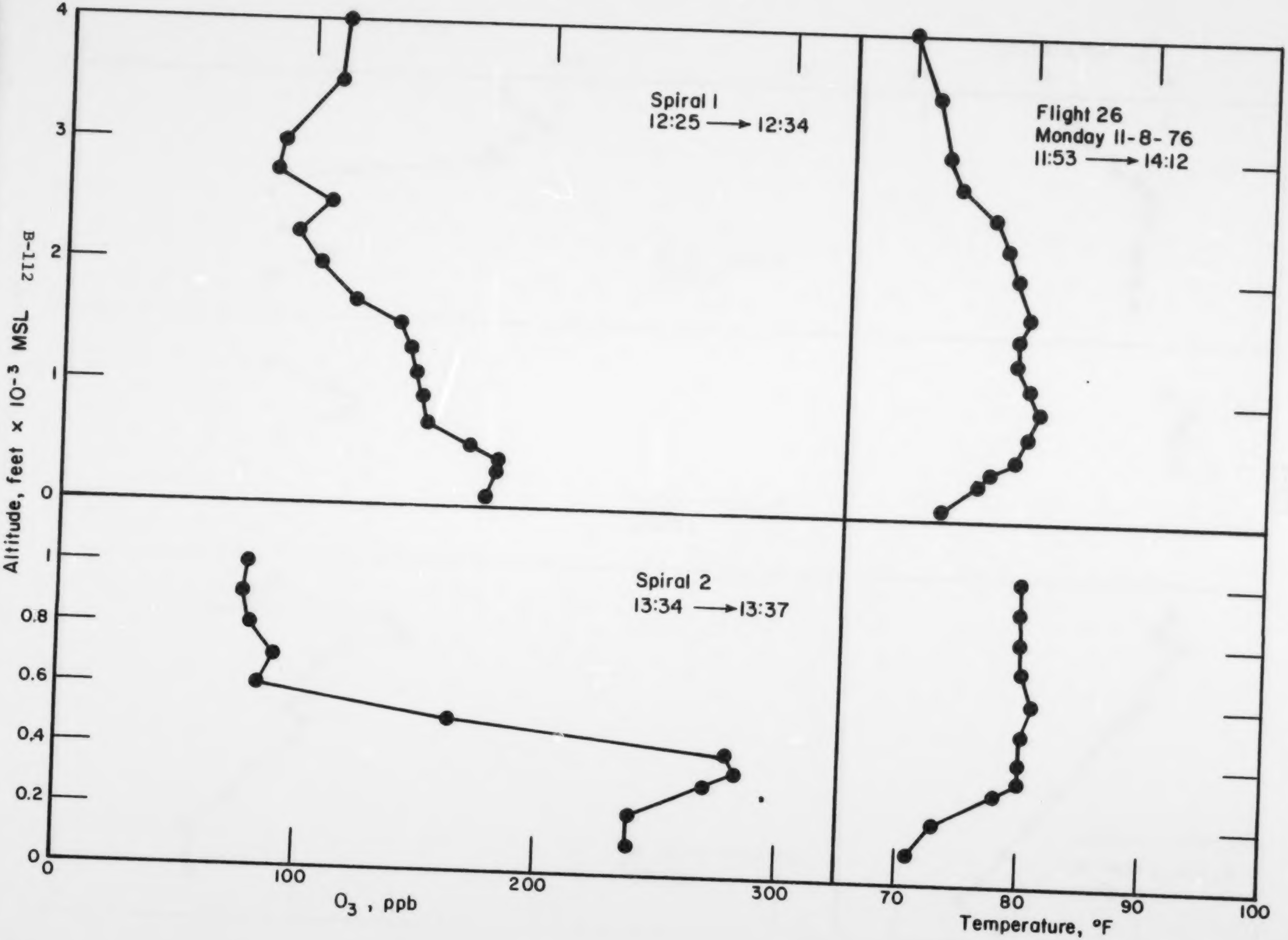

Altitude, feet x 10^{-3} MSL
6
4
2
0
6
4
2
0
0
100
200
300
O_3, ppb
70
80
90
100
Temperature,°F
Spiral
17:03→17:12
Flight 22
Thur. 11-4-76
15:51 —— 18:27

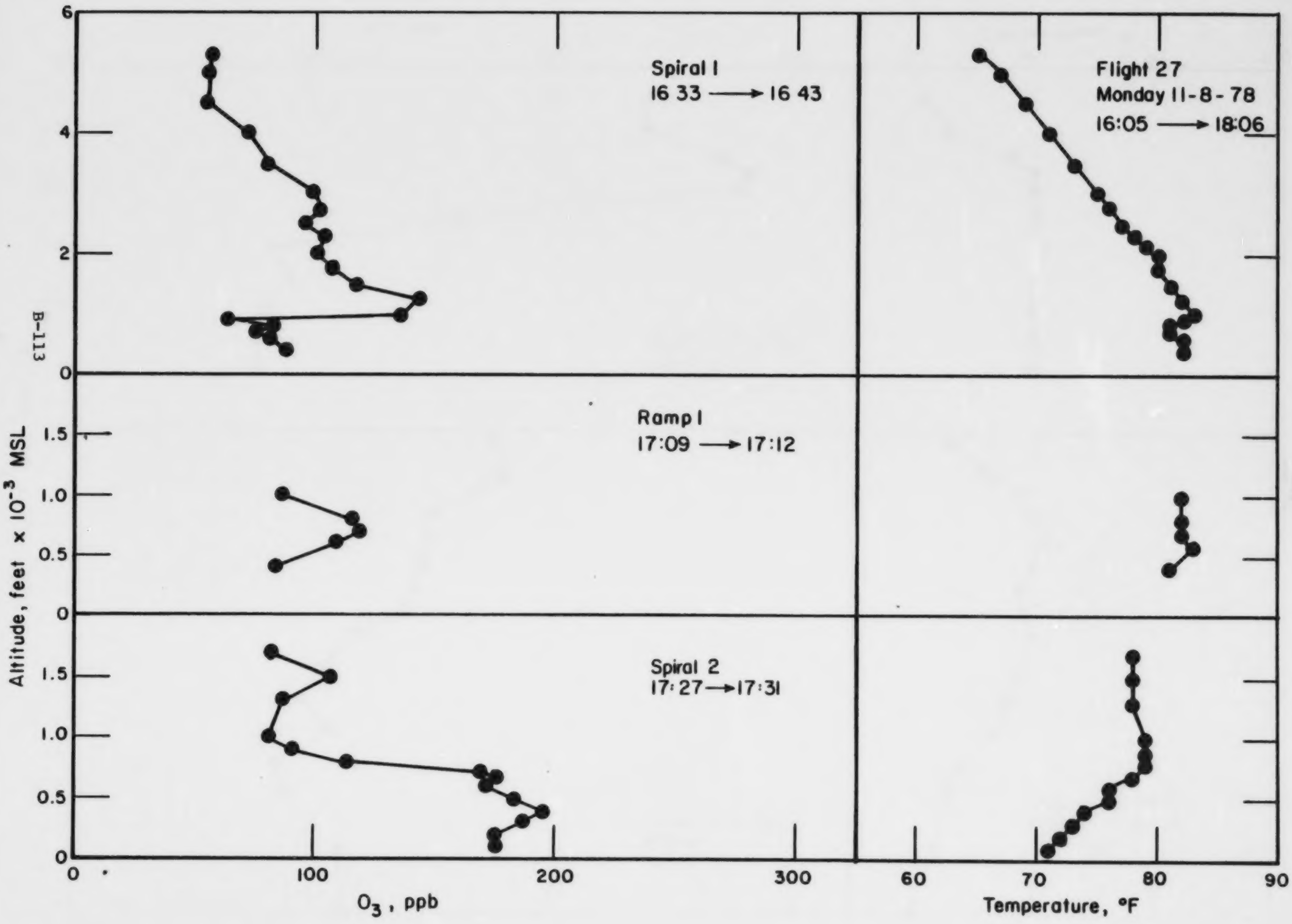

Altitude, feet × 10⁻³ MSL
0
0.2
0.4
0.6
0.8
1
0
100
200
300
O₃, ppb
Spiral 1
17:12 → 17:15
Flight 25
Friday 11-5-76
16:29 → 18:07
70
80
90
100
Temperature, °F

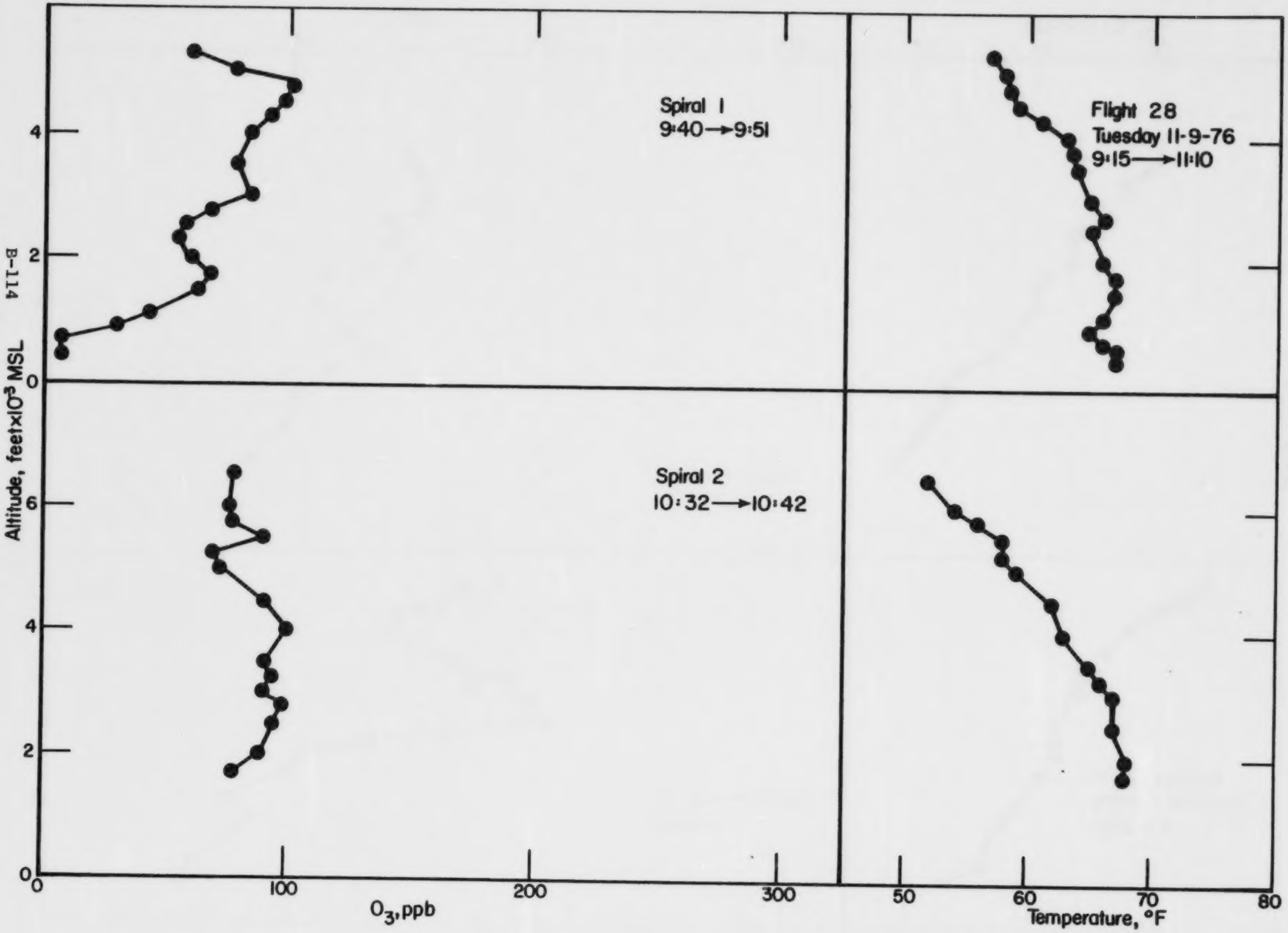

Spiral 1
9:20 ⟶ 9:24
Spiral 2
9:34 ⟶ 9:37
Flight 23
Friday 11-5-76
8:55 ⟶ 10:13
Altitude, feet × 10⁻³ MSL
0
0.4
0.8
1.2
0
0.4
0.8
1.2
0
10
20
30
40
50
60
O₃ , ppb
70
80
90
100
Temperature, °F

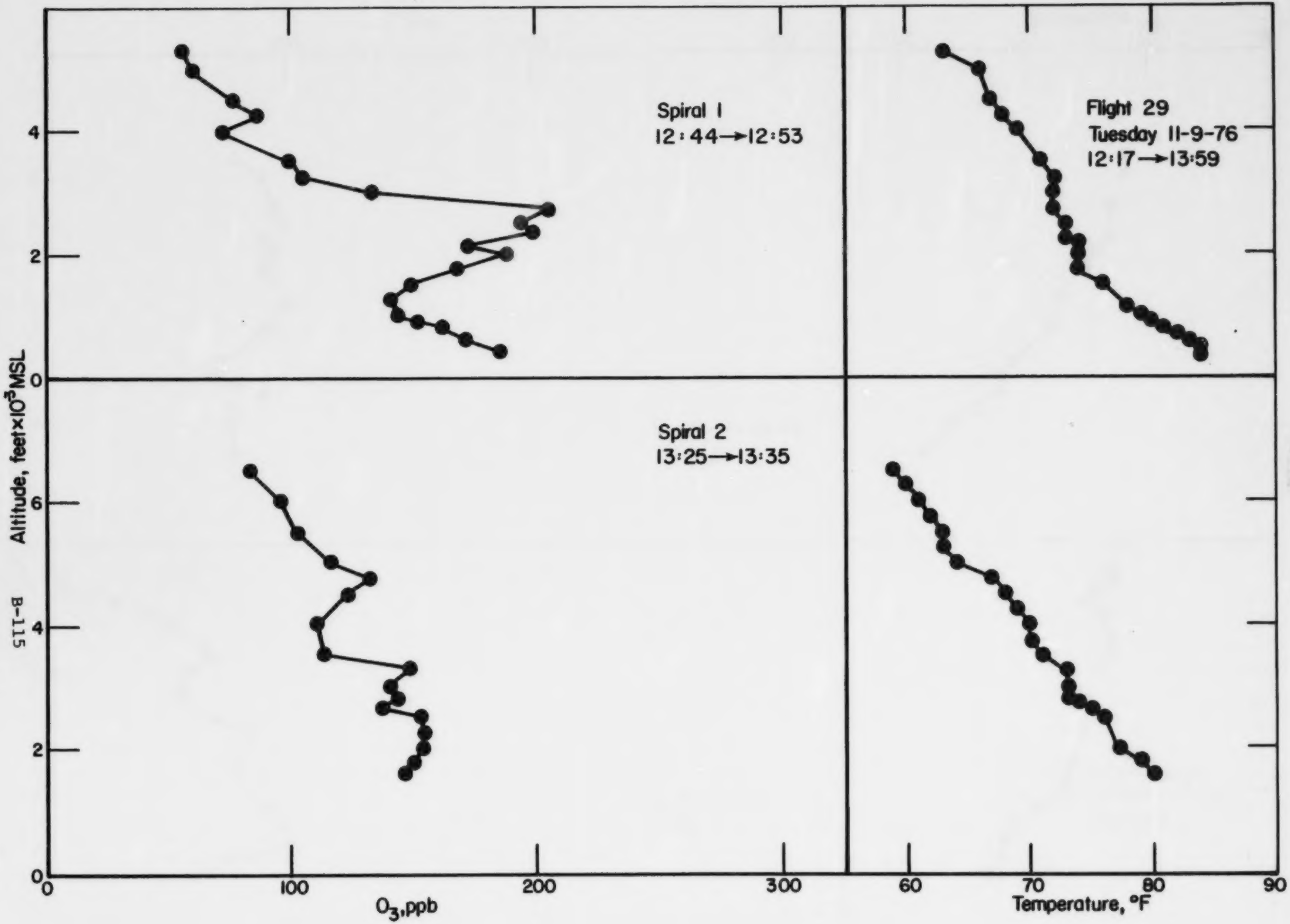
Spiral 3
14:05 ⟶ 14:09
Flight 24
Friday 11-5-76
12:05 ⟶ 14:37
Ramp 1
14:17 ⟶ 14:20
Altitude, feet × 10⁻³ MSL
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
O3 , ppb
70
80
90
100
Temperature, °F

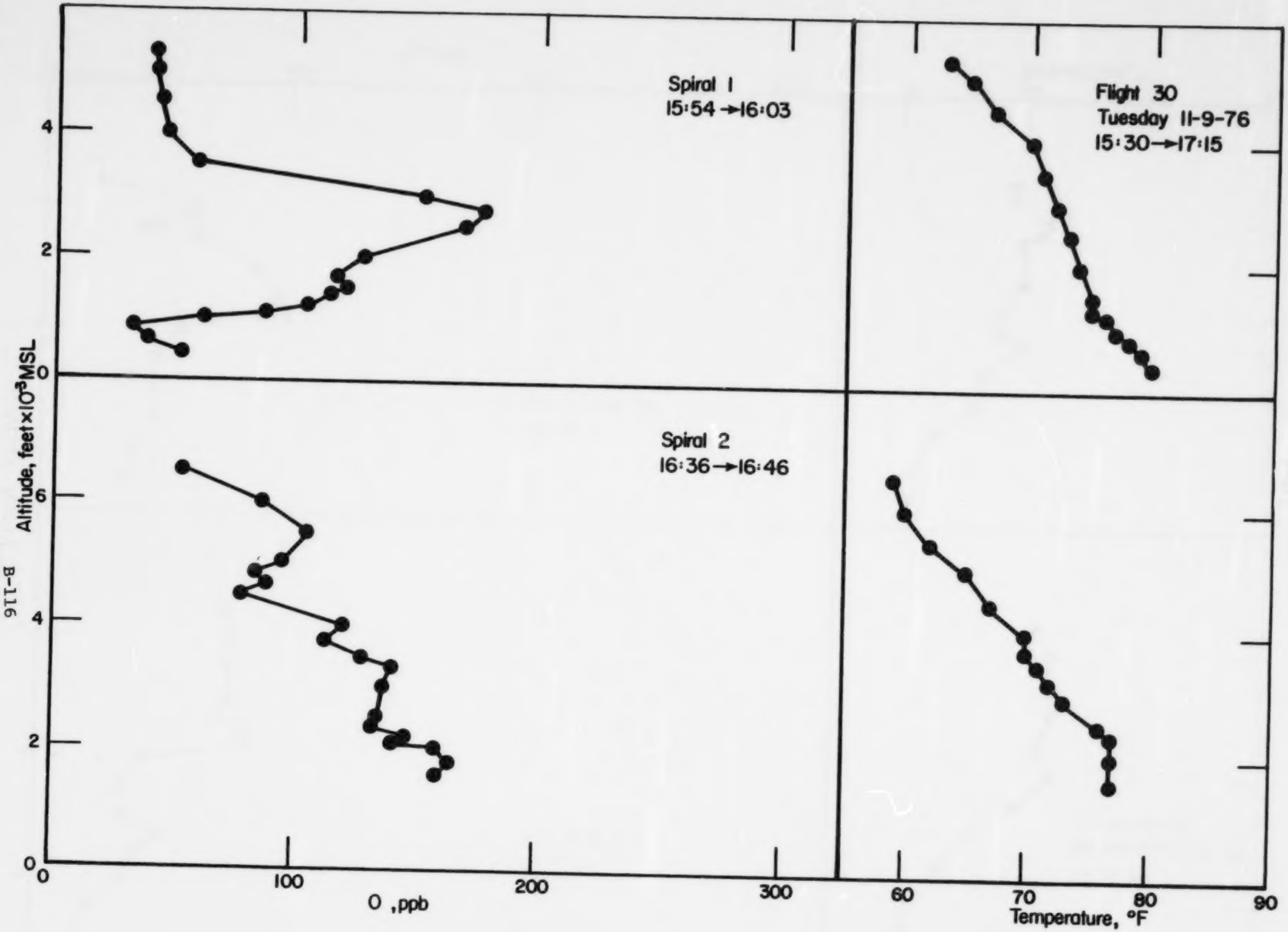

Spiral 1
10:57 → 13:10
Spiral 2
13:50 → 13:53
Flight 24
Friday 11 - 5 - 76
12:05 → 14:37
Altitude, feet × 10-3 MSL
6
4
2
0
1
0.8
0.6
0.4
0.2
0
0
100
200
300
O3 , ppb
60
70
80
90
Temperature, °F

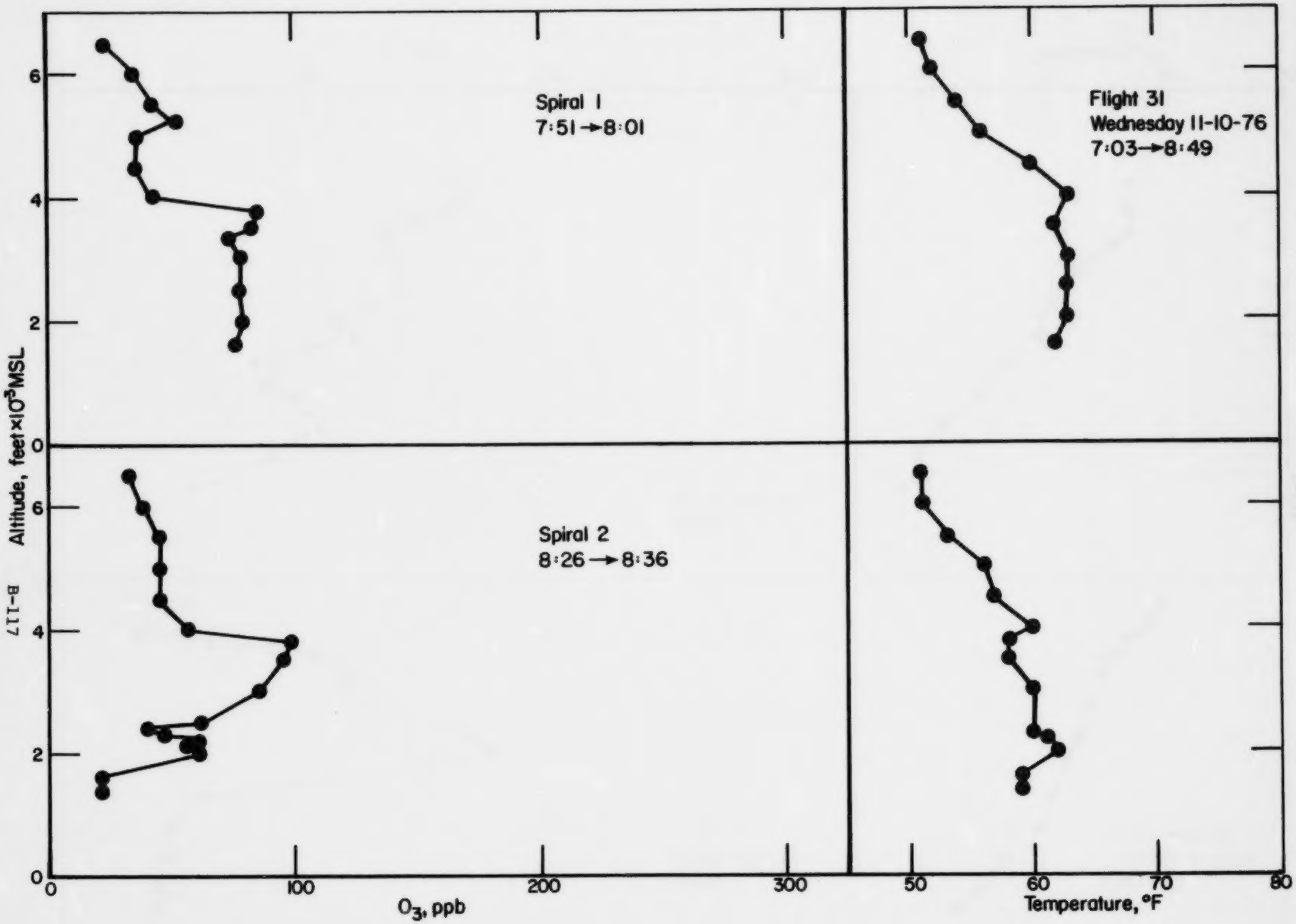

Spiral 1
12:25 ⟶ 12:34
Spiral 2
13:34 ⟶ 13:37
Flight 26
Monday 11-8-76
11:53 ⟶ 14:12
Altitude, feet × 10⁻³ MSL
4
3
2
1
0
1
0.8
0.6
0.4
0.2
0
0
100
200
300
O3 , ppb
70
80
90
100
Temperature, °F

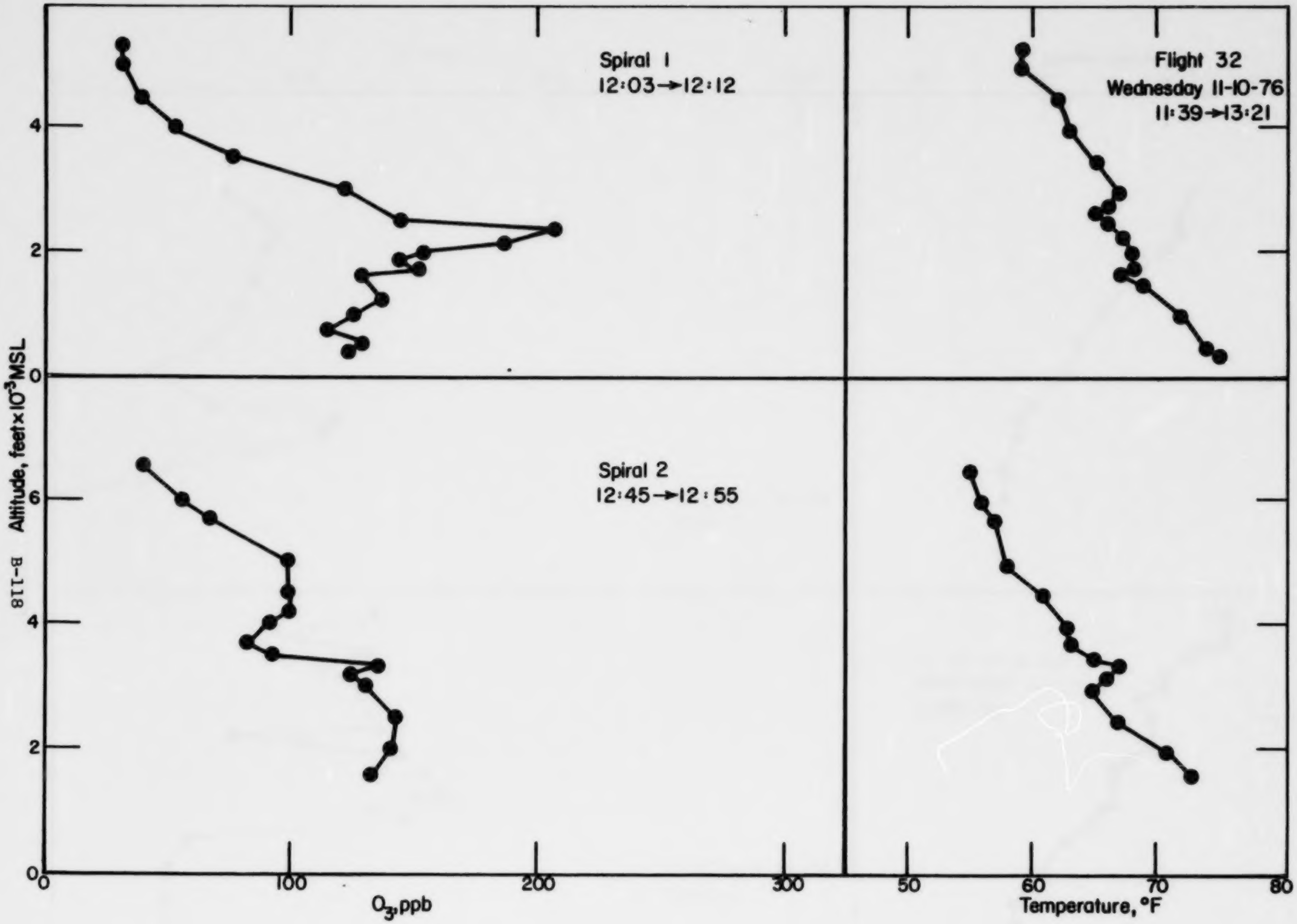

Spiral 1
16 33 ⟶ 16 43
Ramp 1
17:09 ⟶ 17:12
Spiral 2
17:27 ⟶ 17:31
Flight 27
Monday 11-8-78
16:05 ⟶ 18:06
Altitude, feet × 10⁻³ MSL
6
4
2
0
1.5
1.0
0.5
0
1.5
1.0
0.5
0
0
100
200
300
O₃, ppb
60
70
80
90
Temperature, °F

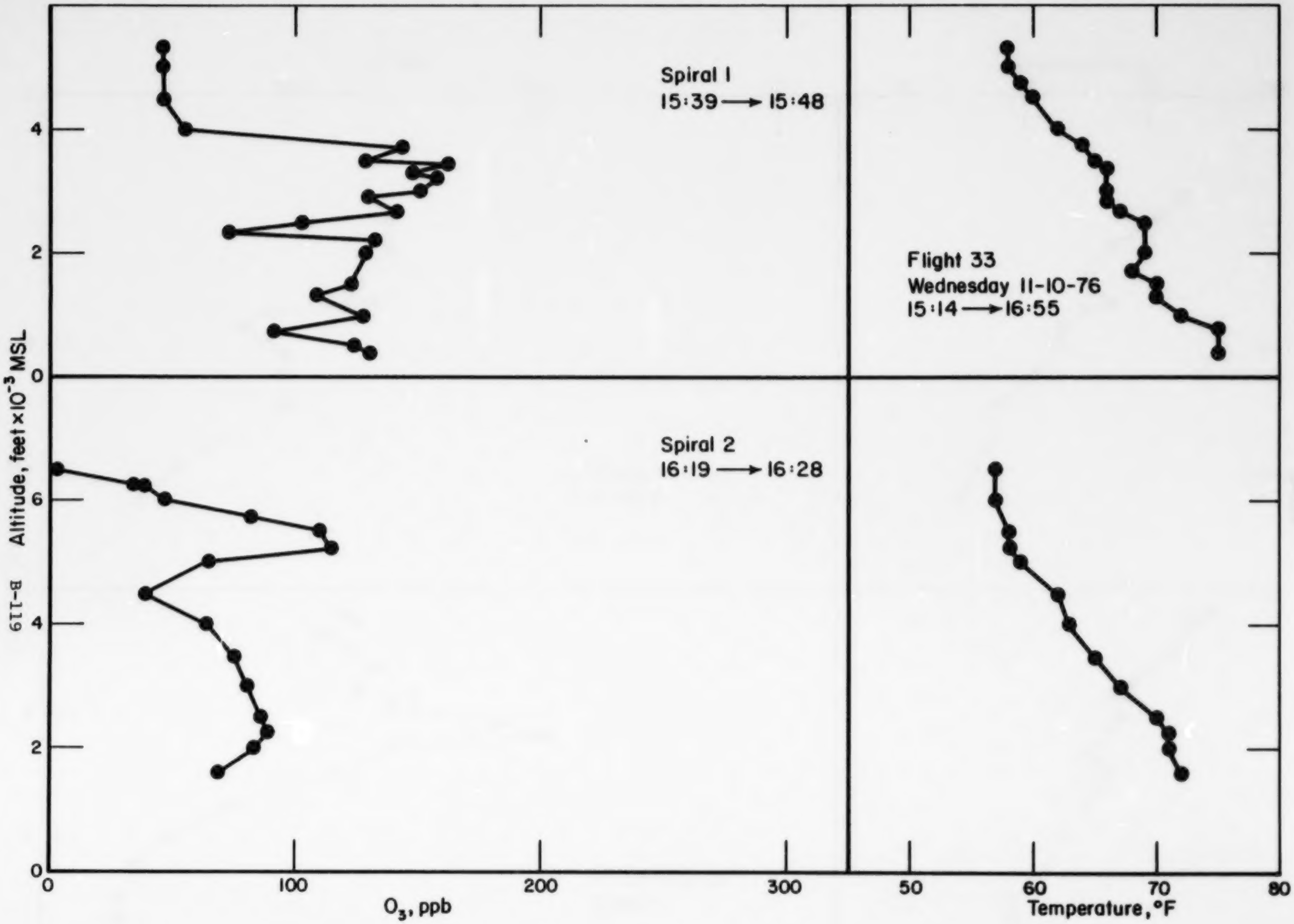

Spiral 1
9:40→9:51
Spiral 2
10:32→10:42
Flight 28
Tuesday 11-9-76
9:15→11:10
Altitude, feet×10³ MSL
0
2
4
6
0
100
200
300
O3, ppb
50
60
70
80
Temperature, °F

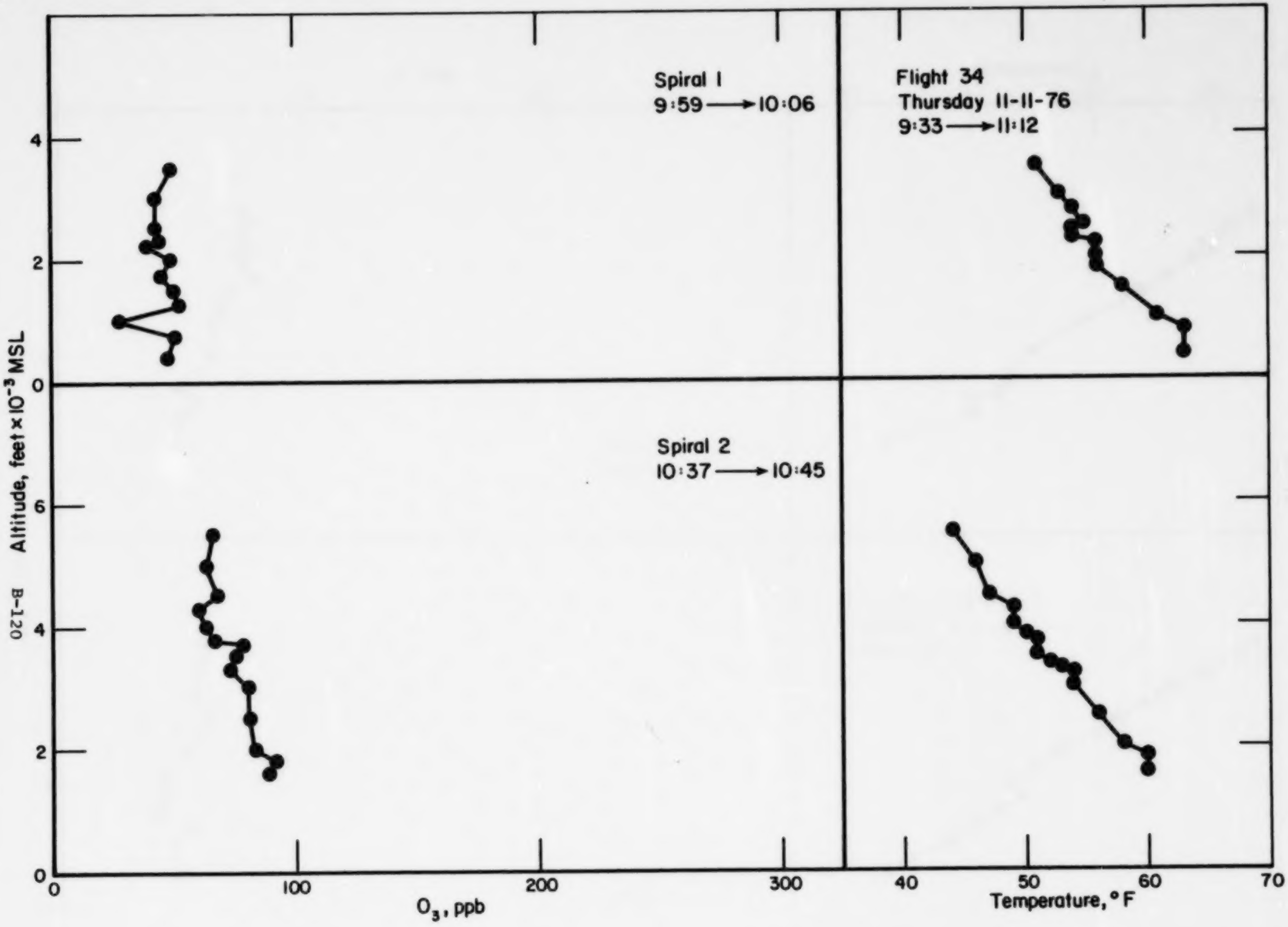

Spiral 1
12:44→12:53
Spiral 2
13:25→13:35
Flight 29
Tuesday 11-9-76
12:17→13:59
Altitude, feet×10^{3}MSL
0
2
4
6
0
100
200
300
O$_3$,ppb
60
70
80
90
Temperature, °F

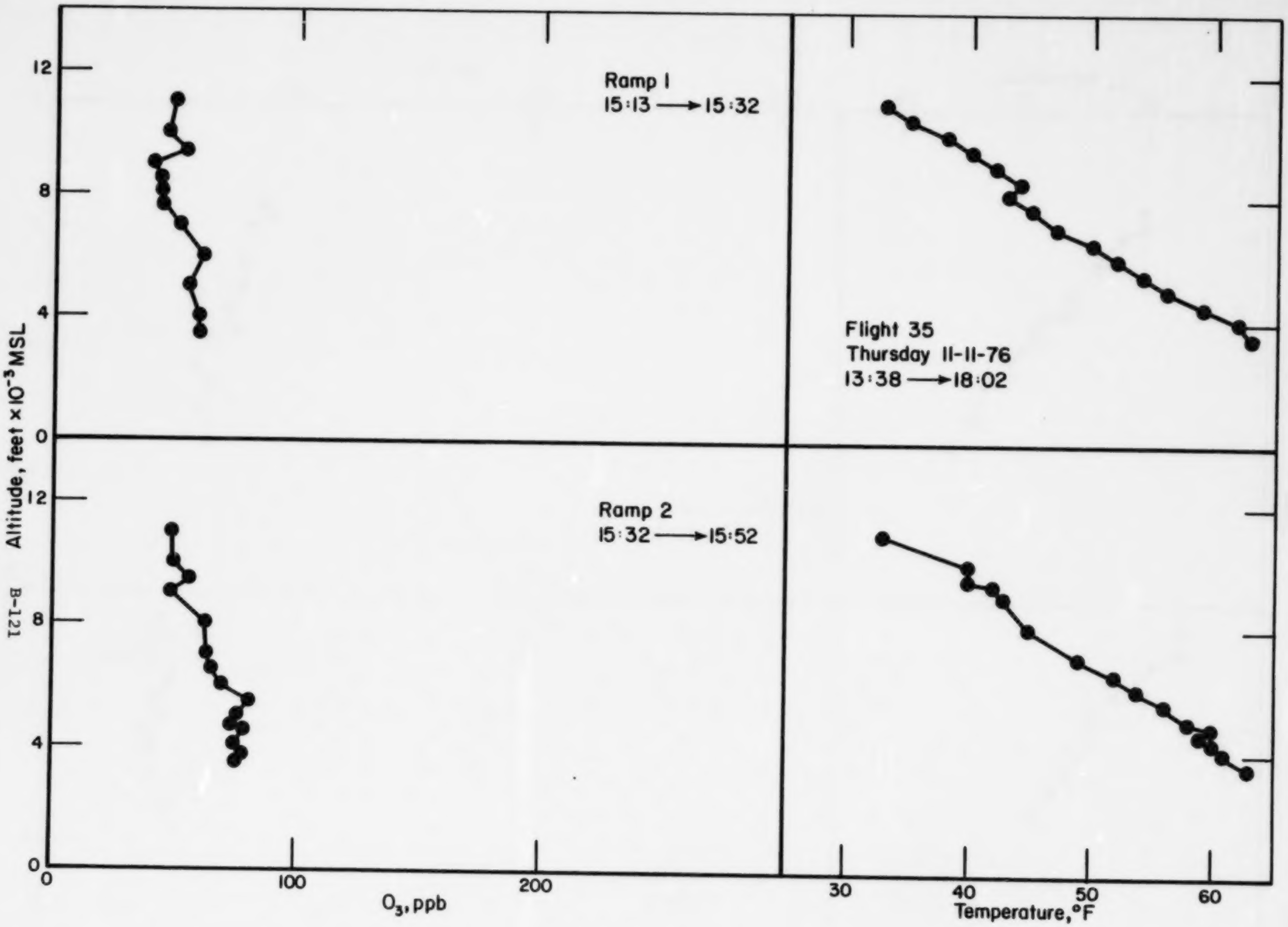

Spiral 1
15:54→16:03
Flight 30
Tuesday 11-9-76
15:30→17:15
Spiral 2
16:36→16:46
Altitude, feet×10³MSL
0
2
4
6
0
2
4
0
100
200
300
O ,ppb
60
70
80
90
Temperature, °F

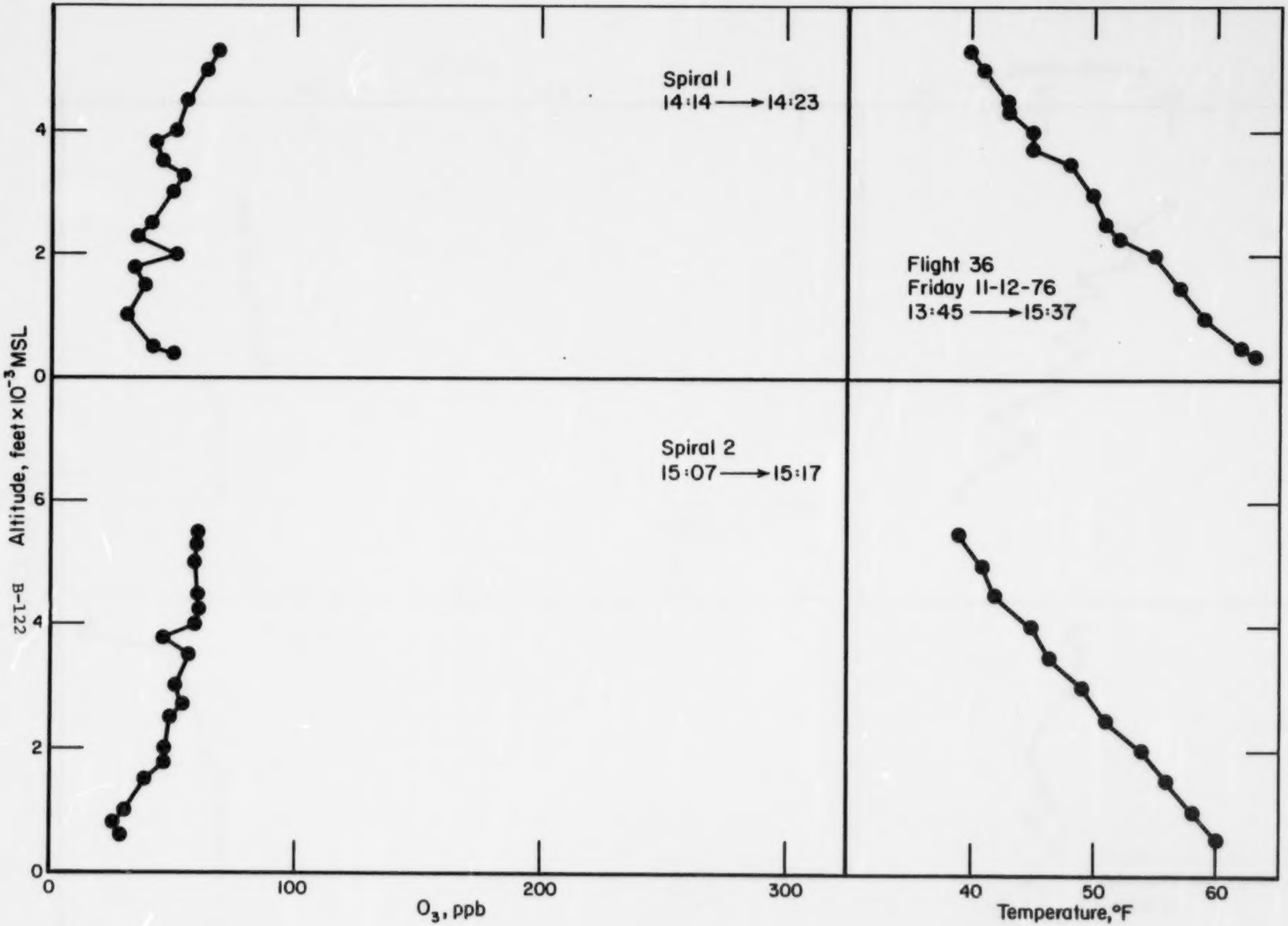

Spiral 1
7:51 → 8:01
Spiral 2
8:26 → 8:36
Flight 31
Wednesday 11-10-76
7:03 → 8:49
Altitude, feet × 10^3 MSL
0
2
4
6
0
100
200
300
O_3, ppb
50
60
70
80
Temperature, °F

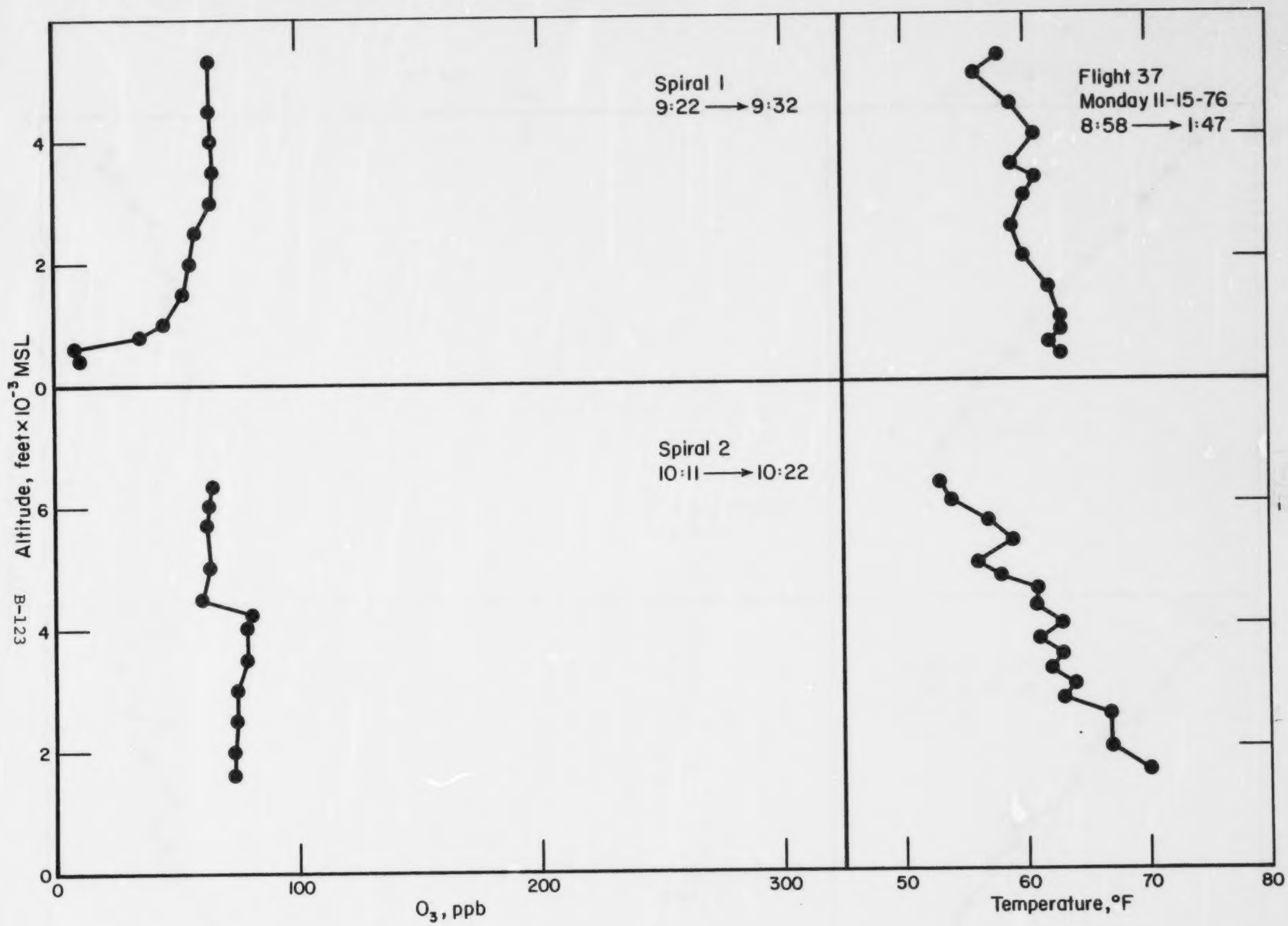

Spiral 1
12:03→12:12
Flight 32
Wednesday 11-10-76
11:39→13:21
Spiral 2
12:45→12:55
Altitude, feet×10³MSL
0
2
4
6
0
100
200
300
O₃,ppb
50
60
70
80
Temperature, °F

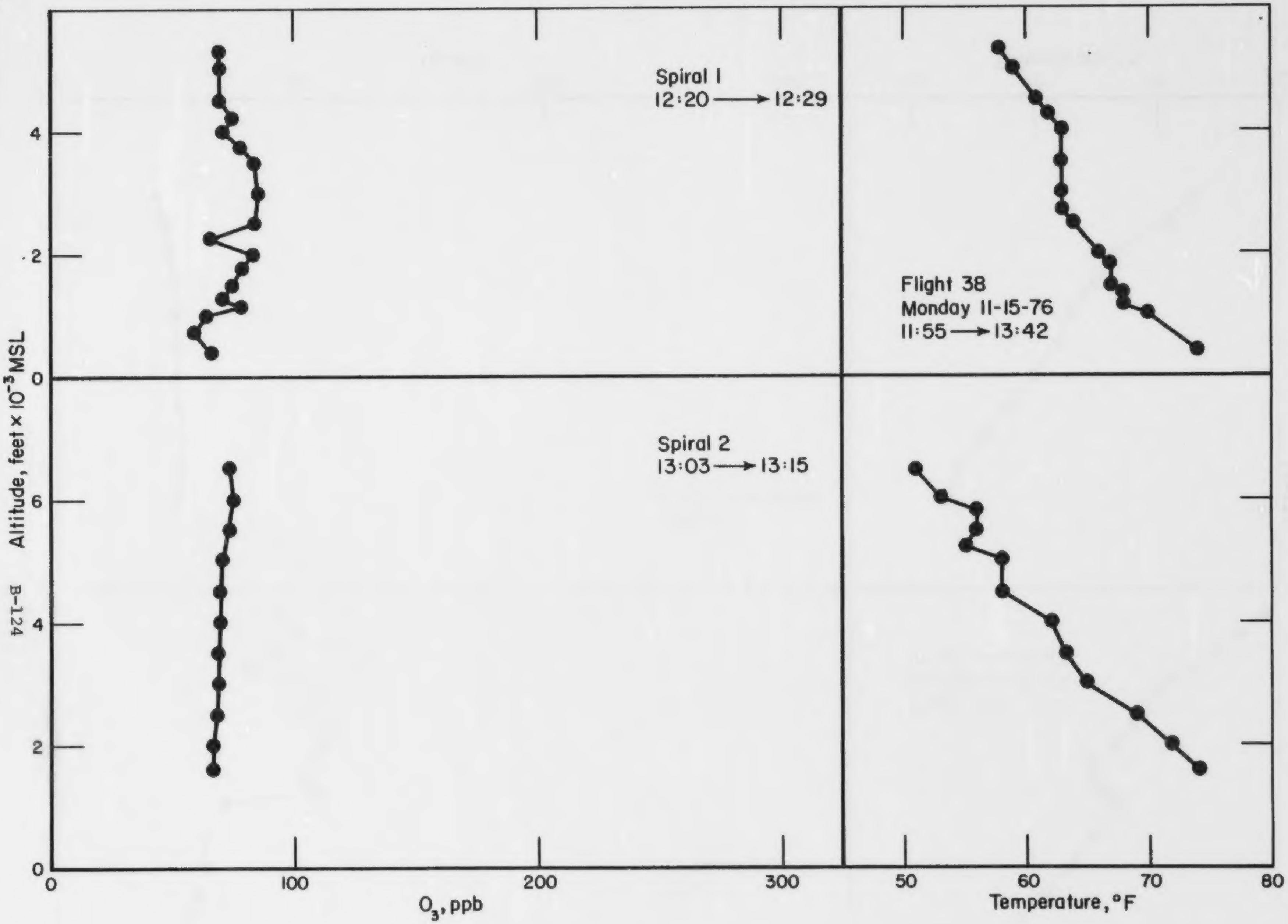

Spiral 1
15:39 ⟶ 15:48
Spiral 2
16:19 ⟶ 16:28
Flight 33
Wednesday 11-10-76
15:14 ⟶ 16:55
Altitude, feet × 10⁻³ MSL
0
2
4
6
0
2
4
O₃, ppb
0
100
200
300
Temperature, °F
50
60
70
80

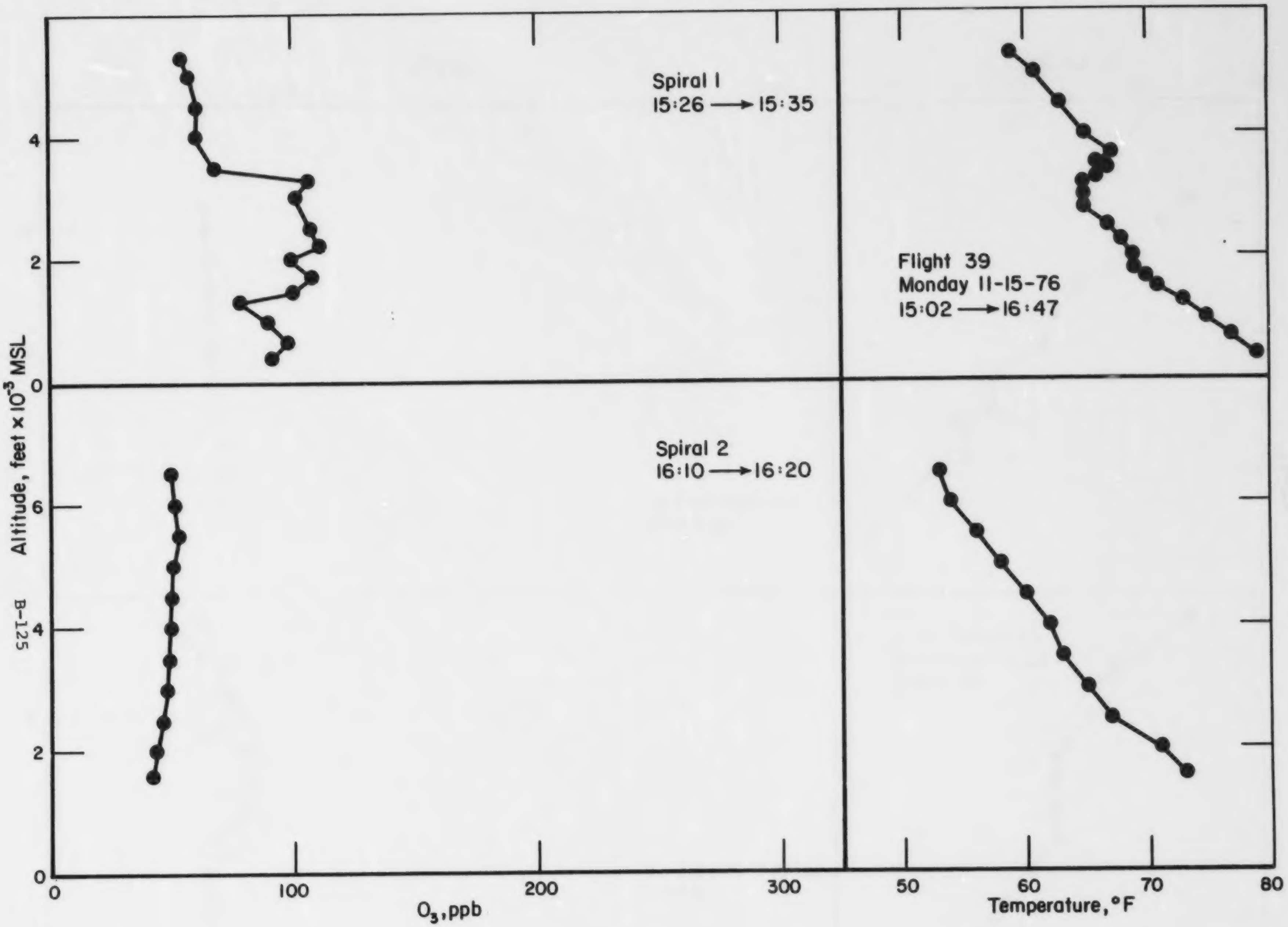

Spiral 1
9:59 ⟶ 10:06
Spiral 2
10:37 ⟶ 10:45
Flight 34
Thursday 11-11-76
9:33 ⟶ 11:12
Altitude, feet x 10^{-3} MSL
0
2
4
6
0
100
200
300
O_3, ppb
40
50
60
70
Temperature, °F

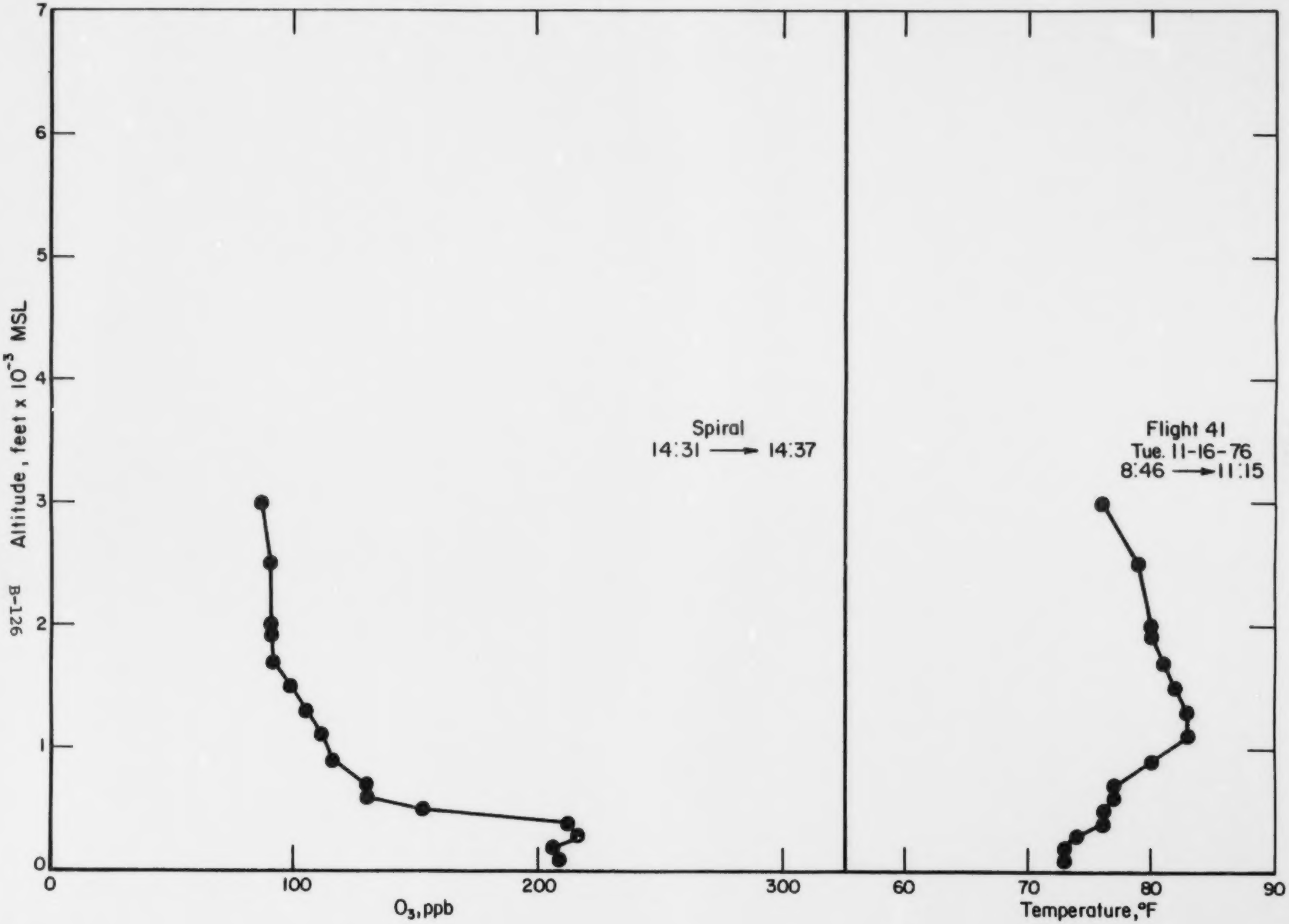

Ramp I
15:13 ⟶ 15:32
Ramp 2
15:32 ⟶ 15:52
Flight 35
Thursday 11-11-76
13:38 ⟶ 18:02
Altitude, feet × 10⁻³ MSL
0
4
8
12
0
4
8
12
0
100
200
O₃, ppb
30
40
50
60
Temperature, °F


Spiral 1
14:14 ⟶ 14:23
Spiral 2
15:07 ⟶ 15:17
Flight 36
Friday 11-12-76
13:45 ⟶ 15:37
Altitude, feet × 10^{-3} MSL
0
2
4
6
0
100
200
300
O_3, ppb
40
50
60
Temperature, °F


Spiral 1
9:22 → 9:32
Flight 37
Monday 11-15-76
8:58 → 1:47
Spiral 2
10:11 → 10:22
Altitude, feet × 10⁻³ MSL
0
2
4
6
0
100
200
300
O₃, ppb
50
60
70
80
Temperature, °F


Spiral 1
12:20 ⟶ 12:29
Spiral 2
13:03 ⟶ 13:15
Flight 38
Monday 11-15-76
11:55 ⟶ 13:42
Altitude, feet × 10^{-3} MSL
0
2
4
6
O_3, ppb
0
100
200
300
Temperature, °F
50
60
70
80


Spiral I
15:26 → 15:35
Spiral 2
16:10 → 16:20
Flight 39
Monday 11-15-76
15:02 → 16:47
Altitude, feet × 10^{-3} MSL
0
2
4
6
0
2
4
0
100
200
300
O$_3$, ppb
50
60
70
80
Temperature, °F


Altitude, feet x 10^{-3} MSL
0
1
2
3
4
5
6
7
0
100
200
300
O_3, ppb
60
70
80
90
Temperature, °F
Spiral
14:31 ⟶ 14:37
Flight 41
Tue. 11-16-76
8:46 ⟶ 11:15